RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

UNIVERSITY OF MICHIGAN

MAIN READING ROOM

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON GOVERNMENT OPERATIONS HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

SECOND SESSION

JANUARY 15, 16, 17, 28, 29, FEBRUARY 3, 4, AND 12, 1958

Printed for the use of the
Committee on Government Operations

UNITED STATES
GOVERNMENT PRINTING OFFICE
20977 WASHINGTON : 1958

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RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

WEDNESDAY, JANUARY 15, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND LEGISLATIVE
REORGANIZATION OF THE
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to call, at 1 p. m., in subcommittee hearing room, George Washington Inn, Hon. John W. McCormack presiding.

Present: Representatives Dawson (chairman), McCormack (presiding), Fascell, Jones, and Harden.

Also present: Orville S. Poland, general counsel to the committee; James Lanigan, associate general counsel; William A. Young, staff consultant; and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK. The subcommittee will be in order. This is the opening statement of a series of hearings which the Executive and Legislative Reorganization Subcommittee on Government Operations will hold on certain aspects of the scientific research and development activities of the Federal Government.

The Committee on Government Operations has the responsibility, under rule XI (8) of the House of Representatives, of studying the operation of Government activities at all levels with a view to determining its economy and efficiency, and of evaluating the effects of laws enacted to reorganize the legislative and executive branches of the Government.

Pursuant to that responsibility, the committee, through its staff, acting at the direction of its chairman, has undertaken an extensive study of what is essentially the efficiency and economy of the management of the Government's scientific research and development activities and of the organizational structure through which those activities are carried on.

The chairman sent to each Federal agency which conducts scientific research and development, 2, and in the case of the military, 3, letters requesting somewhat detailed budgetary, organizational, and operational information. A form copy of these letters will be placed in the record at the close of this statement.

A considerable number of agencies have sent complete replies to the letters and we are assured that the rest are very busily engaged in preparing replies. It is essential to the committee's study that the replies of the latter group be presented at the earliest possible date.

The hearings on this subject are being held by the Executive and Legislative Reorganization Subcommittee because its jurisdiction ex-

tends to matters involving a diversity within the full committee. The present study is governmentwide, involving many agencies, both military and nonmilitary, which carry on scientific research and development activities. Since normally the activities of these agencies fall within the jurisdiction of all seven of our regular subcommittees, a diversity of jurisdiction definitely exists.

The opening phase of our hearings, which we anticipate will continue at least through February, is designed to give to the committee background information on such matters as the place of the United States' science in the world today, the place of science in the United States, and a prognosis for the future on the basis of current trends and current thinking. We are also attempting to obtain a statement of the major problems existing in the field to serve as guidelines as our study progresses.

The end purpose of the study is to insure that our Federal research and development activities are carried on as effectively and as efficiently as possible in a sound, well coordinated, and adequately financed organizational structure. Our national security requires that the Federal Government maintain a vigorous and effective scientific research and development program. Such a program can, however, be seriously impeded by such obstacles as wasteful duplication, excessive administrative costs, complicated procedures, organizational and financial bottlenecks, and a lack of understanding of its full significance. It is, in fact, in order to bring to Congress and the public a better understanding of the subject matter that the hearings will be held in public.

We are both happy and grateful to be able to state that a number of the leading scientists in the Nation have agreed to participate in our hearings. We are sure that those who have been scheduled to appear will make a valuable contribution to the study. There may very well be a number of other persons and organizations who can make a similar contribution of ideas and factual information and who wish to state these to the committee. Those who wish to participate should get in touch with the general counsel or associate general counsel of the House Committee on Government Operations to determine what arrangements can be made for their appearance.

In a later phase, our hearings will deal with specific problem areas in management, organization, and budgets as they are developed in this initial phase and in the committee's study of the documentary material we have requested.

It is anticipated that the later hearings will begin some time in April of this year.

(The letters referred to are as follows:)

FORM LETTER USED IN CIRCULATING DEPARTMENTS FOR INFORMATION

NOVEMBER 13, 1957.

Hon. WILBER M. BRUCKER,
Secretary, Department of the Army,
Washington, D. C.

DEAR MR. SECRETARY: In accordance with its duty of studying the operation of Government activities at all levels with a view to determining its economy and efficiency, the Committee on Government Operations is undertaking a study of the budget requests, budget restrictions, appropriations, and expenditures for basic research, applied research, development and applications engineering.

It is requested, therefore, that the Department of the Army supply the committee with the following information:

1. A definition of their terms "basic research," "applied research," "development" and "applications engineering" as used in responding to the following enumerated items.

2. The amounts requested in the preparation of the annual budgets and of supplemental and deficiency appropriation requests at each level in the Department of the Army for fiscal years 1950 through 1958 for each of the categories listed in question No. 1, showing the nature of the projects for which the requests were made.

3. Following through, for each of the items requested in question No. 2, a statement of the amounts requested by the Department of Defense and by the President.

4. A statement of any budget limitations or restrictions imposed by the Department of the Army, the Department of Defense, the Bureau of the Budget or the President in connection with the making or the preparation of the appropriation requests covered by question No. 2.

5. A statement of the amounts appropriated by Congress pursuant to the requests by the President set forth in question No. 3.

6. A statement of the amounts spent or obligated, showing the appropriation upon which such expenditure or obligation was based and showing whether or to what extent the work was performed by the Government, by educational institutions, by nonprofit organizations other than educational institutions and by private contractors.

7. A statement showing for each category under question No. 6 the percentage expended for overhead and other administrative costs in the case of completed projects. In the case of uncompleted projects, and in other instances where such expenditures are not known, please state the percentages authorized or allocated for overhead and other administrative costs.

It would be appreciated if the above information could be furnished at the earliest possible date, and in any case not later than December 1, 1957.

Sincerely yours,

WILLIAM L. DAWSON, *Chairman.*

FORM LETTER USED IN CIRCULATING DEPARTMENTS FOR INFORMATION

NOVEMBER 21, 1957.

HON. WILBER M. BRUCKER,
Secretary, Department of the Army,
Washington, D. C.

DEAR MR. SECRETARY: Reference is made to my letter of November 13, requesting certain information regarding the budgets, appropriations, and expenditures for basic research, applied research, development, and applications engineering.

In view of recent announcements of "stretchouts" and "speedups" in certain phases of the military programs, the committee wishes to add to its November 13 letter the following additional request for information:

8. A statement showing all directives and instructions, written and oral, affecting appropriations and expenditures for fiscal years 1957 and 1958, having the effect of eliminating, suspending, stretching out, reactivating, or speeding up the execution of basic research, applied research, development, or applications engineering projects and the use of funds therefor.

It would be appreciated if you would include this information in your reply to the letter of November 13.

Sincerely yours,

WILLIAM L. DAWSON, *Chairman.*

FORM LETTER USED IN CIRCULATING DEPARTMENTS FOR INFORMATION

NOVEMBER 22, 1957.

HON. WILBER M. BRUCKER,
Secretary, Department of the Army,
The Pentagon, Washington, D. C.

DEAR MR. SECRETARY: In accordance with its duty of studying the operation of Government activities at all levels with a view to determining its economy and efficiency, the Committee on Government Operations is undertaking a study of the research and development activities at the various departments and agencies

of the Federal Government. Since in at least one major instance applications engineering has been consolidated with research and development, applications engineering is included in the study. The questions which follow are designed to provide the committee with the basic information needed for its study. The committee would be happy to receive any additional information or comments which you believe would be of assistance to it in this matter.

It is requested that the Department of the Army furnish the committee with a complete and detailed statement, including illustrative organizational and flow charts, of the following information:

1. A definition of their terms "basic research," "applied research," "development," and "applications engineering" as used in responding to the following enumerated items.

2. A description of the organization through and by which the four activities listed in question No. 1 are carried out in the Department of the Army. This description should show the duties, functions, authorities, and mission of each component unit in the Department involved in the conception, planning, programing, execution, and financing each of the four types of activities and the relationships among such units.

3. A description of all formal and informal organizational relationships between the Department of the Army, including its component units, and other departments, agencies and units of the Federal Government with respect to the four types of activities listed in question No. 1. This description should show the function of each such relationship and any influence, direction, or controls exerted through such relationships on the Department of the Army's activities and organization in the four fields or by the Department of the Army on the activities or organization of others through such relationships.

4. A description of all formal and informal organizational relationships between the Department of the Army, including its component units, and agencies, institutions, associations, groups, corporations, and individuals outside the Federal Government with respect to the four types of activities listed in question No. 1. The description should show the function of each such relationship and any influence, direction or controls exerted through such relationships on the Department of the Army's activities and organization in the four fields or by the Department of the Army on the activities or organization of others through such relationships. It is intended that this question include all advisory committees and groups composed of persons otherwise outside the Government which deal with matters of research, development, and applications engineering.

5. A description of the methods through which activities in the four fields are carried on; i. e., through private contractors, educational institutions, etc., together with a general discussion of the advantages and disadvantages, as demonstrated by experience, of utilizing the various methods.

6. A description of the major projects carried on by the Department of the Army in the four fields since the beginning of fiscal year 1950, with an evaluation of the actual or prospective results of such projects and a statement of the method through which each such project was or is being carried on.

7. A description of all significant changes including additions and eliminations which have occurred since the beginning of fiscal year 1950, in the definitions, organizations, duties, functions, authorities, missions, relationships, influences, directions, controls and methods covered by the preceding enumerated items, showing dates thereof.

Where information given in response to this request is classified, please indicate the specific material classified and the nature of such classification.

It would be appreciated if the information requested above could be supplied as soon as possible, and in any case not later than January 1, 1958.

Sincerely,

WILLIAM L. DAWSON, *Chairman.*

Mr. MCCORMACK. We have with us, and very glad to have you, Dr. Alan T. Waterman, Director of the National Science Foundation. Doctor, we will be very glad to hear from you.

I understand as each section of your testimony is concluded, that it is agreeable for the members of the committee to ask any question on the contents of each section or portion of your subdivision.

Dr. WATERMAN. That will be very satisfactory.

Mr. MCCORMACK. Thank you, doctor. You may proceed.

Dr. WATERMAN. Would you like, Mr. Chairman, to have me begin by just a brief statement of the mission of the National Science Foundation itself, or could I submit a statement?

Mr. MCCORMACK. I think we all pretty well know what the National Science Foundation is, but I think in your revision it might be well to put that in, unless any other member of the committee deems otherwise.

All right, Doctor.

STATEMENT OF DR. ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY DR. DETLEV W. BRONK, PRESIDENT, NATIONAL ACADEMY OF SCIENCES, AND CHAIRMAN, NATIONAL SCIENCE BOARD; AND WILLIAM HOFF, GENERAL COUNSEL, NATIONAL SCIENCE FOUNDATION

Dr. WATERMAN. Mr. Chairman, members of the subcommittee, events of recent months have brought into sharp focus research and development activities in the United States, as well as the education and training of our young people, particularly in science and technology. It is therefore most timely that this committee should undertake a thorough review of Federal responsibilities in those areas with a view to improving the situation wherever there seems to be a need.

I am happy to appear before you this afternoon, with Dr. Bronk, and to place in perspective, if I can, the objectives and operations of the Federal Government in supporting and fostering scientific research and development and education in the sciences.

The first question is the relative place of the United States historically and currently in the world of scientific thought, activity, and development.

The half century just past has witnessed the phenomenal rise of American technological development to the point where the United States occupied the position of unquestioned leadership.

The growth of the United States as a great industrial democracy began at about the time that new sources of power began to be cheap and widely available. It was an American, Eli Whitney, who is better known for his invention of the cotton gin, who also invented the principle of interchangeable parts and thus helped to lay the groundwork for an era of great industrial expansion based on the growing capacity for mass production.

The history of this period also witnessed the rise of a number of great industrial firms, such as General Electric, Du Pont, Western Electric, Westinghouse, and others. It was firms such as these, whose future depended on new advances in technology, that marked the beginning of large-scale industrial research in this country.

The inventive genius of such individuals as Bell, Edison, Morse, Whitney, and others laid the groundwork, but it was obvious that, in order to maintain their own in the face of keen competition, each company would have to seek constant new refinements and innovations.

Since World War I, the United States has led the world in applied research and technology. In fact, we have come to take that leadership so much for granted that the recent evidence of serious challenge to United States supremacy from the U. S. S. R. has come as a rude shock to most Americans and has brought about a period of intensely critical self-examination and analysis.

The more scholarly type of scientific research into the secrets of nature that we describe as basic or fundamental research developed less rapidly in the United States.

Although the early history of science in the United States is distinquished by such brilliant names as Benjamin Franklin, Joseph Henry, and Willard Gibbs, the United States was largely preoccupied with the problems of an expanding frontier economy. We turned to Europe for our basic knowledge and then applied it with brilliant success.

Our own development in pure science may be said to have begun in the 1920's, in a large way, and has grown rapidly ever since. Whereas a few decades ago science students flocked to Europe to get their training, in more recent years the trend has been reversed.

Some indication of relative standing in quality of research among the nations is to be found in the number of Nobel prize winners. Although the number of Nobel prize winners in science awarded to the United States was low during the early part of the century, it has increased greatly in the last two decades. However, we may not have done so well as other countries in relation to our total population.

Germany, before 1933, or certainly before the First World War, had probably achieved a research strength relative to its population which we have not yet reached. Of the large nations, the United Kingdom has been, and probably still is, at the top in numbers of distinguished scientists and quality of research in relation to population and income. One might also add that on a relative basis, small nations like the Scandinavian countries, the Netherlands, and Belgium have done extremely well.

As for the U. S. S. R., the evidence increasingly shows that as a result of the concentrated efforts of the last few decades, the U. S. S. R. is producing numbers of competent scientists which constitutes a maximum in terms of their total potential. This is an imposing fact. Whether by this means they can succeed in their expressed ambition to dominate the world in scientific and technological achievement remains to be seen. At present, they are not considered to have clear leadership in any field of basic research, except in Arctic research and in certain areas of geophysics. They are, however, excellent in mathematics, astronomy, and theoretical physics, for example, and quite weak in biology. However, they are providing their scientists with modern research facilities at a rate that will be hard for us to match, even if we put forth a strong effort, which incidentally we have not yet done. In all fields, they have high respect for scholarly work, whether applicable or not.

The moral to be drawn from this is that the relative strength in fundamental research of the European countries is the result of their genuine respect for learning, for teaching, and for fundamental research—an attitude which we as a people have never had to the same degree.

Mr. McCormack. Any questions by members of the committee, or Mr. Dawson? Any questions from members of the staff?

Mr. Poland. Dr. Waterman, you apparently make a pretty clear differentiation between basic research and applied research or development. For the record, would you distinguish between them if there is a sharp line that you can help us draw?

Dr. WATERMAN. I would be very glad to, sir. The distinction is probably best expressed in terms of the individual who is doing the work. If his primary aim is to discover something original in nature, and that is his major aim, then one would call it basic or fundamental research. If, on the other hand, his aim is to discover something which can be practical or useful, that would be applied research.

Now this is a subtle distinction and one shades into the other, but the best, the clearest distinction is just that.

Mr. POLAND. That is exemplified then, in your statement with respect to the preeminence of the United States in technology which would be, I assume, applied research in that case.

Dr. WATERMAN. Technology would include everything, really, but especially applied research, development, and production—the sequence of events that led to things that get into use, whether for defense or the civilian population.

Mr. POLAND. And you have indicated, then, basic researchers you have used as illustration—Benjamin Franklin, Joseph Henry, and Willard Gibbs—Willard Gibbs, all I can remember about him was that he was a Yale man. [Laughter.]

Now, can you tell us something else about him?

Dr. WATERMAN. Willard Gibbs, I suppose one could say that he was, by all odds, the greatest pure research or basic research scholar we have had. His work was on the theoretical side largely. It was extremely fundamental and people still turn to his work as authoritative in spite of this lapse of time. He lived at the end of the last century.

Mr. POLAND. In what field had that been, Dr. Waterman?

Dr. WATERMAN. He covered a great many fields; thermodynamics, vector-analysis which is a very powerful mathematical method used extensively in physics and the physical sciences, and chemistry.

Mr. POLAND. Am I wrong in recalling that it has been said that if it hadn't been for Gibbs, that Einstein wouldn't have done all he did?

Dr. WATERMAN. I had never thought of that. I suppose it is true.

First, Dr. Bronk, will you venture your opinion on that?

Dr. BRONK. Having recently spoken at the induction of Willard Gibbs into the Hall of Fame, I have been interested in just this question.

I had dinner with Nils Bohr the night before and I asked him what he thought as to the relation of Willard Gibbs to Einstein. He thought he had done a great deal to make possible Einstein's work and he went on to say, "you know Einstein loved Willard Gibbs." It is significant, I think, in connection with what Dr. Waterman is saying, that despite the fact that Willard Gibbs was installed in the Hall of Fame, there are few people in New York City or the United States generally who were aware of the fact, despite the fact that Willard Gibbs was the most influential man in the development of the American chemical industry, even though he never worked for the chemical industry.

Mr. POLAND. The Chairman just suggested to me the possibility of raising some questions about the present position of the United States in basic research, and I assume you are coming to that as you develop your thesis here this morning——

Dr. WATERMAN. I am.

Mr. POLAND. I was going to ask—you mentioned the awarding of Nobel Prizes and the fact the United States didn't get very many of them up until recently. On what basis are they awarded—on basic research or otherwise?

Dr. WATERMAN. On the basis of achievement in science, and mostly on the fundamental side.

Dr. Bronk, can you answer that more fully?

Dr. BRONK. In the field we are concerned with, leaving out the Nobel Prizes for literature and peace, they are awarded according to the terms of the Nobel will and bequest for a scientific discovery even though it may have no immediately obvious practical implications.

Mr. POLAND. But when you use the word discovery, you almost put that in the classification of basic as extending the field of knowledge.

Dr. BRONK. I would say, yes, sir.

Dr. WATERMAN. The key word is science.

Dr. BRONK. And yet it was awarded for instance, to Sir Alexander Fleming together with Howard Flory for the discovery of penicillin—which within the year of the award was of tremendous practical significance to our Armed Forces and people everywhere.

Mr. POLAND. There is one other question that occurred to me in this connection, and that is the final statement in this section that the moral to be drawn is that we have got to, in this country, stimulate a genuine respect for learning, for teaching, and for fundamental research.

Do you care to indicate how that is going to be stimulated?

Dr. WATERMAN. The scientists, of course, have to pave the way. They have to be more articulate and that is not easy for a specialist to be, because he develops a different language and attitude. I think it depends a great deal on developing the kind of people who can interpret science. This is a special art.

In the last analysis, I believe it depends on convincing our citizens that science is important. If we can do that, by showing them what science is, what it can do, and remove some of the apprehensions about science, then they can be very effective in seeing to it that science is properly taught in their schools and that their children feel a scientific career is a good one if they have the aptitude for it.

Mr. POLAND. I don't want to misuse a term, but do you feel scientists need a public relations catalyst?

Dr. WATERMAN. That would be very helpful. Many scientists are growing more articulate. You see, a man in basic research in science has always been reticent about talking about what he plans to do because he knows very well that he isn't sure what he is going to find. The minute he begins to talk as though he were going to find some particular thing, then his fellow scientists begin to feel he is not a good scientist because they know he may not find it. But one doesn't have to talk about what a scientist is going to do. One can talk about what science is doing and that story is explainable to the public.

Mr. POLAND. The problem is to promote respect for science and scientific education apart from what has happened or what is going to happen.

Dr. BRONK. I think you might ask the question as to why it is that almost every newspaper in the country devotes far more space to ath-

letics than to science. Even though John Finney of the New York Times is here, I would say we need more newspapers which back up their science reporters as does the New York Times and the Baltimore Sun.

Mr. LANIGAN. I notice that in your first item, you state that the United States "occupied" the position of unquestioned leadership in the last half century. Since you used the past tense, do you think there would be any question as to the present status or the future status of the United States?

Dr. WATERMAN. Not as of the moment. This is a true statement in the past tense. It is, in my opinion, true as of the present. The future is the thing that is dangerous.

Mr. LANIGAN. You deal with that later on in your discussion?

Dr. WATERMAN. Yes.

Mr. LANIGAN. I notice you state that the U. S. S. R. is producing numbers of scientists which constitute a maximum in terms of their total potential. Do you mean that they are producing the maximum number in terms of their total population, or what do you mean by "terms of their total potential"?

Dr. WATERMAN. Simply that in their educational system they can identify and encourage all those who have aptitudes for science and see to it that they go into science.

Now, if they start with young children on that basis, one would expect, then, that they will have been able to train all the people who are capable of science training.

Mr. LANIGAN. In their total population?

Dr. WATERMAN. Yes.

Mr. LANIGAN. Would you say that we are far behind in evolving methods by which we can identify and train the potential scientists in our population?

Dr. WATERMAN. I believe so. Of course, the facts are that, of those who graduate from high school who are considered capable of going on to college, only about two-thirds go on, and as one goes into the top brackets of ability, as judged from high school records and tests, this percentage is not strikingly increased.

Now, this is in all subjects and science is an important part of the total.

Mr. LANIGAN. Do you have any figures that would indicate the comparison, the numbers being trained by the United States and by Russia in the scientific fields?

Dr. WATERMAN. Yes, I do. I could give them to you more precisely later. At the moment I think that Russia is training about twice as many as we are, those graduated and specializing in science and this difference is widening.

Mr. MCCORMACK. This means all classes of scientists, engineers?

Dr. WATERMAN. Engineers are generally treated separately. The difference is about the same there.

Mr. MCCORMACK. Not so many years ago it was the reverse, wasn't it?

Dr. WATERMAN. It was the reverse, yes. All this has happened comparatively recently.

Mr. MCCORMACK. Less than ten years?

Dr. WATERMAN. They passed us, I believe, about 1954.

Mr. LANIGAN. What are the steps that you think the United States could take in terms of the immediate future to bring this disparity back into balance? You mentioned encouraging scientific thought and understanding. But do you, as the Director of the Foundation, have any programs in mind that could bring this about?

Dr. WATERMAN. Yes, indeed. There are several ways of getting at this. One is to get at the boys and girls themselves and find out those that have aptitudes and see that their parents know and that they are given every opportunity. The other is to focus attention upon the teachers, because the teachers occupy a very key position. They are probably among the best judges of ability when they see it, and if they are stimulating, know the subject well, and how to impart it, they can get these boys and girls well started at an early age.

The program that the President announced in the field of science education is aimed at remedying this situation and in this, the National Science Foundation is concentrating upon whatever we can do to increase the quality of science teaching, and the encouragement of quality in students. For example, we have had for a few years, and continue to have, summer institutes where high school teachers in a particular science get together at a host institution for 6 to 8 weeks and study the subject which they teach, and how to present it, having with them 1 or 2 research people to explain the modern trend of the subject. Those have been very successful.

We are also financing year-long institutes at 16 universities which provide training at the graduate level in the fields of science for high school teachers selected by the institution—50 to each, and of course we have our graduate fellowship programs. Meantime, the Office of Education has plans to identify and guide boys and girls in the secondary schools and also follow that through by providing scholarships to those who need them to go on into college. In general, they have a program intended to improve the quality of instruction in the secondary schools by doing what they can about such items as teachers' salaries and instruction equipment in the schools.

So these two programs together complement one another.

Mr. LANIGAN. Do you think that it will be necessary for the Federal Government to take a vigorous position with respect to education in science or do you think it is something that can be done through encouragement only by the States?

Dr. WATERMAN. The point that is uppermost in my mind and which constitutes the thesis of much of my testimony here is that this is a very urgent matter. Personally, I am of the belief that education can be handled much more effectively if done locally by the individual communities or the States. The Federal Government can make surveys and point the way—conduct pilot operations to show how the problems can be handled locally. That is the best way. But the problem is one of urgency. Therefore, if it is done in the traditional way, can we do it fast enough? If not, the Federal Government should be prepared with a program which will meet the situation, if only in a temporary fashion.

I would like to refer again to the fact that if one wants to succeed in the quickest possible fashion with any educational programs in the schools, if the parents are convinced it must be done, they, and particularly the mothers, know what to do. So if we could direct our

efforts to convincing them, all these other things will be much simpler to do.

Mr. McCormack. Doctor, it is not within the jurisdiction of our committee to look into that whole question because it comes before another committee. Without excluding the local significance you have referred to, if the emphasis is done locally, the purpose of any such emergency program would be to develop the brains available, get them in the various grades—develop them. In the various schools, its brains that you see, you are developing the capacities to contribute to the national interest. Is that correct?

Dr. Waterman. That is correct.

Mr. McCormack. When you get down to the local level you have local laws that prohibit the use of brains in private schools. You realize that, don't you?

Dr. Waterman. Yes.

Mr. McCormack. And you certainly wouldn't want to exclude brains where that exists, without regard to the school.

Dr. Waterman. No, sir.

Mr. McCormack. So the question has to be very carefully looked into where we can get the maximum results desired insofar as mental ability and capacity is concerned, because you could operate in a manner where there is a powerful segment of our students in the elementary or in the higher institutions of learning that would be desirable to further their education in this field and other fields that would be excluded. That would be unwise, wouldn't it?

Dr. Waterman. Yes, I think so. As a matter of fact, we have an item in our program which is intended to study this situation rather carefully and do some experimenting on what the best thing is to do. The general idea would be to see if certain colleges and universities couldn't take on the job of having the local secondary schools identify the boys and girls with high aptitude from any of the schools in the neighborhood and see if they can be given special attention which is appropriate and, as they go on into college, see that this is maintained. This is a field well worth studying.

Mr. McCormack. The only thought I had was when you get too much power at the State level, they have to operate in accordance with the State law and most of the State laws in this particular field are different than the Federal Constitution. In other words, under the Federal Constitution you can—there is no prohibition against the utilization of brain capacity in any private school system; whereas, when you get to the State level, there is, and most States, but not all of them, are like that; is that correct?

Dr. Waterman. I think so; yes, sir.

Mr. McCormack. So the State level, of course, is very important, but having in mind that this is the utilization of brains and development of them to the fullest capacity to the national limit, that has to be very carefully reviewed.

The Chairman. That same thing wouldn't obtain in Soviet Russia.

Mr. McCormack. No, that is a totalitarian nation.

Now Mr. Poland asked you some questions about basic and applied research.

I have here the hearings of 1954 conducted by a subcommittee of this committee, of which Congressman Riehlman was chairman, and they did a good job and I sat in with them.

Dr. Killian, testifying on June 17, 1954, said—it is very interesting to read his testimony. It covers 22 pages. Have you read it?

Dr. WATERMAN. Yes, but not recently.

Mr. MCCORMACK. In view of his present position that was probably his thinking. He said:

> In this connection, it must be understood that research is not testing, though testing may be a part of research and that research cannot be regimented.
>
> It also must be made clear that research and development are two different things. Research is a kind of creative activity that generates new developments and ideas. Development is taking these ideas and trying to reduce them to practice. Neither of these is effected simply by the rule of spending money. The real effectiveness comes from brilliance and the capacity of men who are conducting the research and development. One hundred mediocre or even average scientists or even 1,000 cannot be equivalent to 1 first-rate man where he has freedom to exercise his imagination.

But coming back to the basic research scientist and the applied, does that fairly cover the situation?

Dr. WATERMAN. Yes, it does. He made the distinction between research and development and the question I was asked included applied research as well.

The difference is simply this: In applied research the man uses regular research techniques to discover whether it seems to be possible to carry the thing to a practical instance.

Development consists of taking it from that point and actually building it, to make it a project. I would agree entirely with what Dr. Killian said.

Mr. LANIGAN. You think the programs that have been proposed for putting into effect in the immediate future constitute the maximum national effort possible in remedying this disparity between the number of scientists being trained in this country and other countries in the world?

Dr. WATERMAN. Maximum is a very large word. It certainly is not a maximum. It is a very significant effort, and it seems to me a wise one in terms of the facts in the case. We want to be rather careful about the extent to which the Federal Government tries to get into these things and also careful about the ways we go about it. A smaller program is in a better position to be modified and increased when it feels the need, or decreased.

Mr. LANIGAN. I wonder if Dr. Bronk has any thought on this?

Dr. BRONK. With regard to which particular question?

Mr. LANIGAN. On what constitutes the maximum effiort. Do the programs proposed constitute the maximum effort to remedy the disparity between this country and Russia in the training of scientists.

Dr. BRONK. I wouldn't say that anything I have heard represents the maximum and the ultimate that could be done. I think that they are certainly forward-looking steps. I think that much more needs to be done. I think that one of the important things that Dr. Waterman has stressed in his prepared testimony is the need for greater emphasis in the public mind on the importance of creative scholarship in the field of science as well as in all other forms of human activity. Until we have that, I don't think the young people are going to be inspired to go into science or other forms of creative activity as a career.

In the first place, unless you have able teachers in the elementary and in the secondary schools, I don't think young people are going to be inspired to go into scientific careers.

How many people of outstanding ability whom you know would be content to be high-school teachers or elementary teachers? If in their homes there is less regard for science, art, and literature and such matters, than there is for merely making money, I don't think you are going to get young people going into teaching.

I was in Berlin at the time of the dedication of the Congress Hall which our Government gave to West Berlin. As I walked around Berlin one evening to see what had happened in the reconstruction, I found in the space of about a quarter mile radius, Leibnitzstrasse, Humboldstrasse, Mozartstrasse, Goethestrasse. I ask you how many streets there are in America named after great mathematicians, educators, composers or authors?

A question I would ask is: What is the prestige value of a career as a creative scientist or scholar?

We had at the beginning of our country a great statesman, a great scholar, a great scientist—Benjamin Franklin. We need more Franklins.

Mr. POLAND. You might have mentioned Harnack House too.

Dr. BRONK. Right.

Mr. MCCORMACK. Doctor Waterman, I notice in your statement to date, in referring to the U. S. S. R. you stated they are excellent at mathematics and quite weak in biology. Can you give us any evidence or information you have as to where they are quite weak in biology?

Dr. WATERMAN. Of course, the outstanding case is genetics. They have worked on theses which biologists of today don't accept.

Mr. MCCORMACK. How long ago was that?

Dr. WATERMAN. About 10 years ago, or more—10 or 15.

Mr. MCCORMACK. You know what advances they have made not only in the educational field, but in the field of research and the practical development of those things that come under biological warfare?

Dr. WATERMAN. In medical science they are doing quite well, but in pure biology they are not.

Mr. MCCORMACK. Have you any evidence you can give us as to what their position is and ability to carry out, for example if they wanted to carry out a biological warfare as a part of any act of war?

Dr. WATERMAN. Mr. Chairman, I am not a specialist in that. That gets into the area of defense, of course, and I am not in position to discuss that.

Mr. MCCORMACK. Well, of course, I don't know much about it. I am just trying to probe to get some information from men who might know. Is it true that biological warfare could destroy people?

Dr. WATERMAN. It has that possibility.

Mr. MCCORMACK. Or destroy the will of the people to fight? Dr. Bronk, this is addressed to you too.

Dr. WATERMAN. These are possibilities. In experimental cases—whether one can achieve it in a general attack, I wouldn't know.

Mr. MCCORMACK. What about chemical warfare?

Dr. WATERMAN. Very much the same there.

Mr. McCormack. Well, you can't contribute much to the advance made by the Soviet Union. Either one of you gentlemen in the field of biological warfare?

Dr. Bronk. I have no knowledge.

Mr. McCormack. What progress has been made by our country that you could disclose at a public hearing that is not inconsistent with our nation interest?

Dr. Waterman. I am only in position to talk really about basic research and when it gets into that area——

Mr. McCormack. You said they are quite weak in biology, fundamental biology. It is based upon the evidence and the observations of 10 years ago.

Dr. Waterman. Yes, sir, and since based upon research material that is published and therefore unclassified, the results that the ordinary academic research people get as they read the articles you see, and talk with the people as they can, and form the opinion of quality in this way. But that would never be classified material.

Mr. McCormack. The National Science Foundation looks into the field of biology and chemical field with relation to possible warfare?

Dr. Waterman. That is not our function, sir. That belongs to other agencies.

Mr. McCormack. I know, but they have looked into it?

Dr. Waterman. I cannot say what they have done.

Mr. McCormack. So you can't give us much information on that.

Dr. Waterman. No, sir.

Mr. McCormack. All right, any further questions?

Mr. Poland. Mr. Chairman, I was wondering in that connection if Dr. Waterman ought not to say at this time what his function is, what the function of the Foundation is?

Mr. McCormack. He can put that in the record. We know pretty well what it is.

Dr. Waterman. For the purpose of this question, it is the support of basic research in all the sciences.

Mr. McCormack. All right, doctor, proceed.

A SUMMARY OF THE RELATIVE POSITIONS OF UNITED STATES, THE FREE WORLD, AND THE COMMUNIST WORLD WITH RESPECT TO SCIENTIFIC EDUCATION AND MANPOWER

Dr. Waterman. Let me begin by saying that it is dangerous to assume that any single country or group of countries enjoy a natural superiority over others in the matter of brains and intellectual capacity. All the evidence points to equal intellectual ability on the part of all nations, particularly those that have developed traditions of education. This category would include, for example, in addition to the Western World, India, Japan, and China.

It follows then that the potential scientific manpower available in the countries of the world is probably the same relative proportion, or nearly so, of the population in each. Therefore, the only advantages in technology enjoyed by any nation lie in the strength and breadth of the general education system, the degree of development of aptitudes among the people for science and engineering—as well as in other fields—their industrial experience and know-how, and last

but not least, the interest and the determination of the people to develop scientific manpower and scientific activities.

At the present time, the United States lags behind most other countries, as Dr. Bronk has pointed out—certainly all of the leading countries—in the understanding, respect, and prestige accorded learning in general and science in particular.

The U. S. S. R., on the other hand, has demonstrated great singleness of purpose and has evolved the most effective procedures for concentrating upon the education and development of scientists and engineers. It has also solved the problem of providing scientists and engineers where needed, either for research or for teaching.

In the recent report by Senator Henry M. Jackson—I might add that another feature of the Soviet education is that all their citizens get a pretty fair understanding of science in their schools. So that the whole population understands science in its general aspects.

In the recent report by Senator Henry M. Jackson, Trained Manpower for Freedom, he observes that—

> Scientific manpower is being graduated in the Soviet Union at a present per capita rate approximately twice that of the NATO community as a whole. Russia now turns out more scientifically trained people than any western nation and is accelerating the output at a higher rate than any nation. Furthermore, Soviet instruction is of high quality.

The weakness of the Soviet system lies in the probable incompatibility of developing free research to the utmost under a totalitarian system. Furthermore, it is questionable whether under the training given in a totalitarian system scientists and engineers can acquire the same breadth of view and insight which come with a free system.

However, whether these weaknesses constitute a serious threat to the continued advance of the Soviet Union remains to be seen. In any event, in the short term their system must be regarded as formidable, and it should be clear that the only advantage which the United States can hope to achieve depends upon the quality of performance.

This in turn depends upon the kind of cooperation and broad know-how that come only from well-rounded tradition and experience. We are now realizing, however, that the breadth we have is not enough unless it includes a full complement of topnotch, highly trained and imaginative specialists. Among the latter, scientists and engineers of the highest equality and in requisite numbers are indispensable.

Mr. McCormack. Any questions? Mr. Chairman, any questions?

The Chairman. No.

Mr. McCormack. Mrs. Harden?

Mrs. Harden. No.

Mr. Poland. Do you feel, Dr. Waterman, that a democracy is at a disadvantage as compared to a totalitarian system when it comes to obtaining a single necessity of purpose?

Dr. Waterman. Quite the contrary. When a democracy is determined to do a thing, it seems to me this is a far more effective system.

Mr. Poland. To go back to an illustration, by Dr. Bronk, that the mothers of America be most influential in persuading the children in this country to enter scientific pursuits? There are some other methods? You feel that is a more effective method then by the government of a totalitarian state?

Dr. Waterman. I think so.

Let me illustrate by the difference in the treatment of scientists that we have. If we allow a scientist freedom to do what he wants and he makes up his mind what he thinks is significant for him to do, he can do that much more successfully than if someone tells him what to do. This is deeply ingrained in a democracy and it is a fundamental strength, in my opinion.

Mr. POLAND. You touch that on the following page of your statement, that it is questionable, the training given under a totalitarian system. Do you feel at present in the Soviet they have got away from the difficulties they had in their genetics at the time of Lysenko when genetics science had to follow the dialectic or do they still have it?

Dr. WATERMAN. This is Dr. Bronk's field more than mine, but I think that has been corrected and their biologists are now free from this restriction.

Dr. BRONK. So far as I know, this is true.

Mr. POLAND. So that would pick up some of the slack the chairman spoke of a while ago because of that business of the past.

Mr. LANIGAN. I just want to ask about the statement that the only advantage the United States can hope to achieve depends upon the quality of performance, and stressing quality as contrasted to quantity.

Dr. WATERMAN. Broadly, whatever one does.

Mr. LANIGAN. Do you think that we can match them in quantity of scientists as well as in the quality of our scientists?

Dr. WATERMAN. In my opinion, quality will win over quantity anytime, unless you have quality with the quantity. That is a general statement, if I interpret your question correctly. I mean if you have quality performance, then you have quality performance in individuals, in the organization, and in the country, so that you know how to do all aspects of the problem at hand, whether this is fighting a war or combating a disease or any other thing. If you have quality performance all along the line and the deep kind of know-how that goes with experience and management supervision, that is the kind of quality I am talking about.

Mr. POLAND. I take it you think we have a real job on our hands to achieve and maintain this type of quality. It is something that we can't assume we will automatically achieve?

Dr. WATERMAN. That is correct.

Dr. BRONK. There is one interesting aspect of that in the field of science. If you have a large amount of second-, third-, and fourth-rate scientific research being done, you can so flood the literature and so encumber the body of scientific knowledge that there is a tremendous amount of time spent by first-rate scientists in trying to winnow out what is important.

Dr. WATERMAN. Yes.

Dr. BRONK. That accents the point that you must have high quality; a lot of mediocre scientists can be worse than none.

Dr. WATERMAN. For example, in a given field of research, if half the papers published are no good, then the good people waste a lot of time trying to find out which is good and which is bad.

Mr. MCCORMACK. We have the brains in America, don't we?

Dr. WATERMAN. Yes, indeed.

Mr. MCCORMACK. We have the facilities?

Dr. WATERMAN. Yes, but improvements are needed.

Mr. McCormack. What is the fault?

Dr. Waterman. Not enough people who have aptitude are going into higher education.

Mr. McCormack. That is long range. It is true there has been that reversal, and I recognize that, but we still have more people in the field of science than the Soviet Union has.

Dr. Waterman. I think it is hard to match these up, because the numbers of people—the classes—are not quite comparable, but I think the evidence is the total number engaged in science isn't too far different.

Mr. McCormack. It is the immediate future.

Dr. Waterman. That is quite right.

Mr. McCormack. But, on the other hand, we have the brains in America, in the field, both basic and applied. We have the facilities. Now, what is it that failed to have them click, in your opinion?

Dr. Waterman. In the short range, we could provide a great deal more support to the competent basic-research people than we are doing.

Mr. McCormack. I am getting away from education. I am getting away from the practical problem that confronts us. Would you say it is top management?

Dr. Waterman. No; it is a matter—it comes down, to some extent, to just a matter of financial support of the competent research scientists of the country. Only a fraction of them now are receiving support which they need and, also, we have been behind in providing them with research facilities for very basic research. We have been very good on the applied side, but, on the basic side, the tools they need are not forthcoming, as they should be. I will refer to that a little later.

Dr. Bronk. I think the important thing is that we don't have adequate facilities. The brain potential of our country is tremendous, but we don't use it most effectively. We don't give them enough facilities to work with. On the other hand, we should not persuade ourselves that we are no good at all. The very fact that more Americans have received Nobel prizes in the last 15 years than has Russia is one indication.

Mr. McCormack. All right; you may proceed.

Dr. Bronk. May I say, Mr. McCormack, one thing further? The last sentence that Dr. Waterman read in this section:

> Among the latter, scientists and engineers of the highest quality and in requisite numbers are indispensable.

I think what the committee is interested in is the relationship of the National Science Foundation to our military security. We are not charged with this as a specific, explicit responsibility, but it should be borne in mind that we do have a vital role in our national military security. Scientists and engineers of the highest quality and in requisite numbers are indispensable to our military security and, by training people, by building up our body of scientific knowledge, by strengthening our technology, we are laying a firm foundation for the military security of the immediate and the more distant future.

Dr. Waterman. The same thing applies, Mr. Chairman, to the progress in science in the country. The progress of science is a very interesting thing. Everyone contributes a bit or a piece to this progress. This makes all the difference, for example, in a new develop-

ment where the engineers need up-to-date information. If our research is progressing rapidly, then it would be the very latest information they get, and this all counts in making the thing successful. Quite superimposed on these numerous small advances is the occasional sensational discovery, but, unless all these people are supported, then this has less chance of appearing. That can make all the difference between remarkable success and just the average run of the mill.

Mr. POLAND. One question occurred to me in connection with the question you asked about management. Would you say that management was concerned, largely, with the utilization and, perhaps, the overall direction of the products of basic research where the financial support which you suggested a moment ago is essential would be the support for basic research as distinguished from its subsequent management direction?

Dr. WATERMAN. The subject of management direction in basic research is really not applicable, except to use good judgment in choosing the ones you want to back. After that, management enters and is very influential and effective in industry and the Government in putting these ideas to use—that is where management plays a big part.

Mr. POLAND. So, then, you would amend your prior testimony to the extent of asserting that management is a very important factor when it gets to the stage where management attaches?

Dr. WATERMAN. Yes, and, in technology, this is one of our greatest assets.

Mr. MCCORMACK. All right, Doctor.

SCIENTIFIC FIELDS IN WHICH THE UNITED STATES HAS LAGGED AND IN WHICH IT HAS FORGED AHEAD, AND THE EFFECT OF THE ACTIVITIES AND POLICIES OF THE FEDERAL GOVERNMENT IN SUCH CASES

Dr. WATERMAN. In general, the United States has made the most notable progress in the fields of research that underlie the principal technical industries. Such fields include electronics, solid-state physics, high polymer chemistry, biochemistry, nuclear physics, computer design and technique, a number of fields of biology, agricultural research, low-temperature physics, applications of nuclear energy, and certain types of space research involving rockets and balloons. We have lagged most conspicuously in the earth sciences, not a serious lag, a category of research that includes such important fields as meteorology, oceanography, geophysics, certain fields of geology, and now the opportunity for satellite research of outer space.

United States facilities for research and development are in many respects outstanding. Both industrial and Government laboratory equipment, test stations, and other installations have been models for the rest of the world. By contrast, modern college and university laboratories have been showing great need of renovation, new construction, and modern equipment. Scientists returning from the U. S. S. R. report that great effort is being expended on laboratories and instruments; and even in the case of such costly equipment as high-energy accelerators, no expense is being spared to make them as efficient and advanced as possible.

Mr. MCCORMACK. How important is it in the field of basic knowledge applied in the satellite in the outer space activities?

Dr. WATERMAN. I believe that is very important, Mr. Chairman.

Mr. MCCORMACK. First, from a military angle and second from a civilian. How many angles of peaceful pursuits—peaceful usage?

Dr. WATERMAN. On the military side——

Mr. MCCORMACK. First, is it important?

Dr. WATERMAN. It is important.

Mr. MCCORMACK. Will you state why? I don't mean only today but projecting it, based upon your knowledge and experience.

Dr. WATERMAN. It is important for the same reasons that fields of basic research underlying military affairs are important, namely as we reach to higher and higher altitudes and to higher and higher speeds in missiles and planes, we reach to the limit of the atmosphere and get into outer space.

Now, we must know what happens to objects that go through outer space, how they can travel properly, what is the most efficient way of doing this, what can they accomplish, to what disturbances are they subject? Therefore, we need to know all we can scientifically about the nature of this space, what it does to objects and humans and what use it can be so that the exploration of this scientifically is a very necessary background to anything that we may do involving the flight of missiles or men through that region.

Now, on the purely scientific side, this is opening up a vast field of discovery and understanding and knowledge of the universe which we can only begin to glimpse. This is, after all, the first time man has ever succeeded in coming anywhere near the notion that he could travel outside the ordinary influence of the earth's gravity and as such, it is a very imposing thing.

It raises a number of interesting scientific problems which probably may pave the way to extremely practical and far reaching benefits to man.

For example, if we had observations from outside the earth on the influences that reach us from the sun, and those are much more than just the heat and light, we would know then what influences our atmosphere and our weather in a big way. We would get at the fundamentals of that.

So the promise of space science in the field of understanding and possibly what we can do about it is very great. In the same way, we know that in these upper regions, disturbances reach us from the sun and from outer space which affects us by causing blackouts in communications that can be very serious. If we make observations in that space and determine what those disturbances are, we would be in a good position to eliminate those blackouts and also possibly provide new means of communication.

From the standpoint of science alone perhaps the biggest problem is a huge one indeed. It is that as we, of course, know the earth receives all its light and heat from the sun and the sun is part of a huge engine you might say which is manufacturing power for us and sending it to us in all sorts of forms—this is what the earth receives. Some of it is retained in various forms and some goes off again, but we do not know how this big engine operates. If we can get into the middle of it and see how the components behave; namely, the sun and earth, like the furnace and condenser of an engine, then we could undoubtedly draw some very fundamental conclusions, but

these are things which we are only on the brink of discovering and they are of very great importance.

You have noticed I have said nothing about space travel, but I think the first step is to explore this space thoroughly and scientifically so that we will be in much better position to judge whether such a thing is feasible or useful.

Mr. McCormack. If a potential enemy of ours was to have a decided lead in that, in the control of outer space and utilization of it through satellites or other means, it could be to our serious disadvantage from a military angle, is that right?

Dr. Waterman. It could be if they know more about this then we do, and they could use it to better effect.

Mr. McCormack. As a matter of fact, these satellites could be later used for military purposes, couldn't they?

Dr. Waterman. Those particular satellites?

Mr. McCormack. I am not talking about them. The ones they might develop later.

Dr. Waterman. This is possible.

Mr. McCormack. Well, there is a rollcall going on and we will have to go over there and we will be right back. Will you wait for us?

(A brief recess was taken.)

Mr. McCormack. The subcommittee will be in order.

All right, Doctor Waterman, will you proceed?

EFFECT OF ACTIVITIES AND POLICIES OF THE FEDERAL GOVERNMENT

Dr. Waterman. Generally speaking, with the exception of agriculture, it is only since World War II that Federal policies and activities in support of science have begun to be felt in a national way. Prior to that time, Goverment participation in, and support of, scientific research and development was on a relatively small scale.

Excellent results were produced by such agencies as the National Advisory Committee for Aeronautics, established in 1915, which conducted an outstanding program in aerodynamics; certain branches and departments of War and Navy Departments were producing valuable results in their laboratories; and, of course, such scientific activities as agricultural research, public-health research, and the National Bureau of Standards were of long and honorable standing within the Government establishment.

But it was the full impact of science and technology upon military weapons and strategy during World War II that brought not only expansion of the Government's research and development activities in its own laboratories, but introduced the widespread use of the research and development contract as a device for securing needed results in a minimum of time.

Under the auspices of the Office of Scientific Research and Development, the Government contracted for research on a wide variety of problems ranging all the way from the development of DDT and penicillin to the research that led to the first atomic bomb. A major feature of the war effort was the major role played by the colleges and universities in carrying on research and development under Government contract.

The effects of Government policies and practices in support of research during the war were obviously good. Not only were the

major weapons and devices that played a crucial role in the war produced under this system, but support was also given to a certain amount of fundamental research, and the effects were found to be desirable.

The continuation of Federal support for research and development by contract and by grant by such agencies as the Department of Defense, the Atomic Energy Commission, the Department of HEW, and others has produced excellent results for the Government.

Nevertheless, there is a growing concern lest the extent of the Federal research and development program encroach upon the universities' normal functions of teaching and research.

It has become apparent that the universities are depending more and more upon such contracts and grants to support the research of regular departments of the universities, particularly in the fields of the physical sciences. This situation is partly the result of the Federal Government's cautious support of basic research as contrasted with the heavy support for applied research, development, and engineering.

Although the basic research programs of such agencies as the Office of Naval Research, National Institutes of Health, Atomic Energy Commission, the National Science Foundation, and others have won the respect of the scientific community, there is general agreement that the total effort has been far too small.

For example, since the establishment of the National Science Foundation in 1950, requests for assistance to the Foundation alone have regularly exceeded the funds available by 4 or 5 times, and the Foundation could have supported about 3 times as many meritorious applications as it has been able to support with the funds available.

Although up to now the Federal Government has provided significant support for wind tunnels, computer development, nuclear reactors, and accelerators, the lack of Federal funds for radio and optical telescopes, and oceanographic vessels, has been a contributory factor in the lag of the United States in these fields.

In oceanography, for example, it is well known that the Soviet Union has in service several major research vessels constructed and equipped for oceanographic research and operated under the direction of scientists. The United States has no comparable vessels of its own, and the 2 or 3 ships being used for this purpose are reconstituted vessels, entirely inadequate to the need; in fact, one of the principal vessels in use looks as though it were left over from a whaling fleet.

Mr. McCormack. Any questions?

Mr. Jones. Mr. Chairman, I would like to ask the doctor one question on page 8.

Doctor, one of the things you have stated there that excited my curiosity was the effect that a great deal of research and development activities of the Federal Government had been done on a contractual basis. Are you of the general opinion that those contracts on scientific research and development are best carried on through a contractual program rather than the activity of the Government itself?

Dr. Waterman. That is a very large question, Mr. Jones. I refer to it later in this paper in more detail. There are several ways in which the Government can do this. It can do it in its own laboratories. It can do it in a very common way of making contracts, largely with industry, to produce certain things, develop and produce them and also with universities and it can establish national laboratories as the

AEC has done which are under contract, but operated by an agency. That is larger sort of unit.

Mr. JONES. Do you have any fears that the research program will be retarded and restricted under those contracts executed by the Federal Government by the unwillingness of the corporate enterprise to carry out the research unless it has positive assurance that it will make money for the corporation?

Dr. WATERMAN. This would apply to industrial contracts?

Mr. JONES. Yes.

Dr. WATERMAN. That can happen of course. It can happen in several ways—one is provided the industrial concern does not have and has to acquire the facilities and personnel for the purpose. That is a delay and they may not succeed in obtaining the right kind of facilities or personnel.

The other is when what the Government would like to have the organization do interferes with the profitmaking side. Those are quite natural things and they do have to be watched.

Mr. JONES. Have you seen any evidences of those companies receiving Government contracts, procuring people skilled in the technical field, holding them in reserve, and not utilizing them to the fullest extent for making their services available when their duties are not wanted at the moment?

Dr. WATERMAN. This has been reported to have happened in some cases and I suppose it really depends on the degree of importance that the Federal Government attaches to their work. If the Federal Government says this is a really essential thing, as for defense, then I think the private concern will cooperate. If it is of lesser importance, then it would not perhaps get the same attention.

Mr. JONES. Mr. Chairman, I don't want to impose on the time of the committee. Those are some of the questions that have been going through my mind and giving me some source of concern and that is the reason I directed those questions. Maybe they are of such general nature that the committee would not want to elicit that kind of information, but I have one more question and then we will let the doctor proceed.

Do you think that the argument always extended as to why the Government has not been successful in its program of research, is because it had to compete with private industry who paid a great deal more money to their employees than the scientific mind could obtain by employment within the Federal Government; that there has been a practice on the part of industry to raid Government installations that had the technical minds and know-how that have brought about impairment of scientific research by the Government itself?

Dr. WATERMAN. This has undoubtedly been a factor, Mr. Jones, especially in recent years where there has been so much need expressed for getting on with the whole technology. It's a handicap in the Government laboratory. They cannot compete in salaries.

Mr. JONES. And don't we run into that proposition on the contractual basis to where a Federal installation will be housing the research of a Government project and at the same time house a research of some contract firm and the contract firm is always reaching over and getting the technical people, hiring them out from under the Government research program and placing them in their own categories at a much higher increase which retards the scientific research

and development taking place in Government installations? Have you noticed that?

Dr. WATERMAN. That can happen and there have been reports of this. This is again dependent, I think, on the priority the Government attaches to it because in making negotiations on a very high priority project the Government takes steps to prevent its happening. Its always possible, you see, in negotiations, if the technical people know who the competent people are in the firm, to specify that these people are going to be involved in the project. The possibility you mention exists because of what you might call a fair-practices understanding, when the Government places a contract with a firm, and sets limits on the salaries of the people employed on it.

Dr. BRONK. Mr. Chairman, in answer to Mr. Jones' question, there are two observations that I would make.

In the first place, a really good scientist or engineer is not going to sit on ice as it were, doing nothing very long. If a company were to try and freeze a group of people for some future eventuality, I don't think they would hold them very long.

Mr. JONES. I wasn't expecting that the Government itself would hold them.

Dr. BRONK. I meant the industry.

Mr. JONES. The industry that has the contract?

Dr. BRONK. I don't think they would sit there doing nothing very long, because a good scientist or engineer has curiosity and a desire to be doing something. There are a few instances of what you suggest, but I think they are rare. Secondly, in regard to competition between industry and Government: In the good traditional pattern, I think that competition, like cooperation, is a powerful stimulus to achievement. If industry competes with Government and they can get people away from Government, I think it's a good thing for the Government because it will force them to improve the conditions under which the scientists and engineers are employed. Just as in the university field, those of us who are presidents of institutions which aren't quite so wealthy as other institutions regret seeing another university come in and offer our faculty salaries we can't meet. But in the long run it is good for our institutions, too, to have the competition which forces us to go out and raise our salary level.

Mr. JONES. Thank you very much. Thank you, Mr. Chairman.

Mr. POLAND. Mr. Chairman, I should like to ask Dr. Waterman if Mr. Jones' question would be the same if it related to research work done by research institutions of universities.

Dr. WATERMAN. That brings out another point that is worth mentioning. The universities are a good example where a good scientist or engineer is not just looking for salary. In general, the salary is lower than in industry, but the compensations are very great. He may like teaching; he may like the idea of dealing with young minds, graduate students, and he is left with great freedom to pursue his own course of research and he doesn't have to channel his thoughts along certain lines for the benefit of a Government laboratory or industrial laboratory. Thus in the past there has been a differential, on the average, between the scientist in industry and in the university or Government. Recently that differential has gone way out of bounds because the industry jobs have paid much higher—so much higher that this upsets that kind of equilibrium.

Mr. POLAND. Is the major portion of your contacts with industrial concerns or the basic researchers connected with the universities?

Dr. WATERMAN. Chiefly with the universities. We are not allowed to operate any laboratories, so what we do is provide financial assistance for research work—what they need in the way of equipment and facilities and personnel.

Mr. POLAND. And Mr. Jones' question would perhaps more largely relate to applied research, that being done in industrial institutions than the basic research which is done pursuant to grants which you make. And most of the moneys which the National Science Foundation has it gives away, doesn't it?

Dr. WATERMAN. I don't like the "give away" part—we get value received.

Mr. POLAND. But the large portion of your budget is expended in terms of grants for a return in the form of the product of basic research, so it is not retained money or money you spend in your own laboratory at all?

Dr. WATERMAN. No; we are not permitted to do that at all.

Mr. LANIGAN. I have a question on the statement you made about the equipment being made available to the scientists in Russia. You mention such equipment as high-energy accelerators. Can you give us a little more information on the quality and quantity of equipment that is being made available to the scientists in Russia?

Dr. WATERMAN. In the first place they make it all themselves. They will occasionally copy a foreign instrument, if it is just what they want. But in the construction of these big machines they do all the work themselves and, our scientists who have been there say it is very high quality work in detail and every other way. It is not daring—rather conservative but very soundly constructed and complete. They are given every incentive to get on with this; there is no delay; if they want something they get it, provided it is on a high-priority job.

Mr. LANIGAN. Well how do Russia and this country compare in the development of high-energy accelerators and in the plans for the immediate future?

Dr. WATERMAN. That story is told very simply; the facts speak for themselves. We have at the University of California at Berkeley, a nuclear accelerator, the largest we have, which produces 6 billion electronic volt protons, and that is in good operation. The Russians have one which gives 10 billion, and that is in operation. In Brookhaven National Laboratories, under AEC contract to them, there is a machine under construction which is aimed at producing 25 billion electron volts. The Russians have one aimed at 50 billion under construction. So they are a step ahead of us all the way.

Mr. LANIGAN. Why are high energy accelerators important in research work?

Dr. WATERMAN. They are important in the field of nuclear physics because the whole riddle of nuclear physics is how the nucleus of the atom is constructed and how it behaves. On this depends the application of nuclear energy in its various forms. Any advances in the field would have to depend on how this atom behaves. The nuclear accelerators provide very high speed nuclei as projectiles that strike the other nuclei and produce complicated effects which the operators of these machines then study in detail. Out of this wealth of information

come the new ideas. At any point thereafter a whole new phenomenon or explanation may come out which will make all the difference in understanding the nucleus and its applications. Now the faster one projects these nuclear bullets at other nuclei, you see, the more information you may get and the more chance of getting something new. So this is a frontier in nuclear physics that has to be pushed forward. We have to keep up with it in order to be sure we are going to miss no bets, and that our knowledge is fully up to what mankind is capable of obtaining.

Mr. LANIGAN. Has the Defense Sciences Research Board—Research Advisory Board, I believe—taken any position with respect to the United States constructing a 50 billion volt accelerator?

Dr. WATERMAN. We think that that is indeed a thing which should be encouraged, and this is under active consideration now.

Mr. LANIGAN. Could you tell us what difficulties in programing and budgeting, in getting approval, have been experienced in connection with the 50 billion volt accelerator for the United States?

Dr. WATERMAN. One thing necessary is a completely feasible plan with the objectives all clear as to how we are going to construct it. When you are working the frontier of instrumental development there are lots of novel ideas that can improve the economy and efficiency of a new machine, and, indeed, you can't push back the frontier unless the new ideas occur. So part consists in having a well-laid-out plan in being, new ideas which you know are going to succeed in construction, and the other depends on what types of these high-speed projectiles one is going to use. Electrons can be used or the nuclei of hydrogen atoms or helium atoms. Thus you have several types of projectiles possible and each one calls for a different type of machine. At the present time there are plans being studied for several types of machines which can go beyond our present limit, and I believe it is very important that as these plans come to fruition they should be carried out.

Mr. LANIGAN. I am speaking now about the organization of the Government. Are there any difficulties with respect to which agency of the Government should construct a 50 billion volt accelerator?

Dr. WATERMAN. Of course, the Atomic Energy Commission has been the main operator in the field, and the Office of Naval Research has a joint program with them in the field. As a matter of fact, the Office of Naval Research began this program before the creation of the Atomic Energy Commission and then developed a joint program. The three main agencies concerned in future plans are the Department of Defense, the Atomic Energy Commission, and the National Science Foundation. The National Science Foundation is interested because this is basic research. The AEC is interested because that is their major field of development, and they need to have research which underlies their development. So, it is quite possible that, as these plans mature, those three agencies will do what they can to promote activity in this whole field, either jointly or separately.

Mr. LANIGAN. Then I take it that no agreement has been reached as to which agency would carry out the construction and it hasn't been put in any agency's program as yet?

Dr. WATERMAN. Not definitely, no; but this matter is under consideration right now and I am sure we can come to agreement.

Mr. LANIGAN. How would that decision be reached? Just by agreement of the three agency heads?

Dr. WATERMAN. Yes; and the administration, of course.

Mr. LANIGAN. What do you mean by "the administration"?

Dr. WATERMAN. The Bureau of the Budget would have to approve the request for the funds presented by each, and thereafter, if one agency did it, that would have to be approved with their budget; if it were done by another, in their budget—or jointly, the approval would be required of both.

Mr. LANIGAN. Have you got to the stage where you are considering including this project in the budget of any agency?

Dr. WATERMAN. This question hasn't been settled yet. As soon as we come to an agreement I'm sure we can go forward. It is a very important thing to do, for the reasons I have stated.

Mr. LANIGAN. If 1 agency, rather than 3, say, had the total responsibility for this project, you think it would be farther on its way than it is at the present time?

Dr. WATERMAN. Well, I don't know. These are—each agency looks at their interest in a project from a slightly different point of view, and I think it's healthy that that should be. It seems to me it is desirable for more than one agency to support in a field like this.

Mr. MCCORMACK. What is the approximate amount involved in such a project?

Dr. WATERMAN. The cost of these is going up rapidly and—well, this now runs in the tens of millions, depending on how ambitious the scientists and engineers think they can be. But I have forgotten what the figures are—for the Brookhaven one it would be somewhere in the order of 20 to 25 million.

Mr. MCCORMACK. On the project at Brookhaven—this is the one they are planning—what does that run?

Dr. WATERMAN. About 25 million for their 25 billion electron volt machine.

Mr. MCCORMACK. That is in the process of construction now?

Dr. WATERMAN. Yes. To offset this cost, the scientists come up with variations and simplifications from time to time which bring about a reduction in expense. Several of these inventions have resulted in less need for iron, for example.

Mr. MCCORMACK. That is a speculative field and is bound to happen in almost any endeavor.

Mr. LANIGAN. What significance from an organizational and scientific research standpoint do you put on the fact that the Russians have a 50 billion volt accelerator under construction and we're still in the discussion stage? Do you think that sheds any light on the position of science in the two countries?

Dr. WATERMAN. Ultimately this will have an effect if it continues—if the Russians continue to be ahead. But I can see no good reason why that should happen if we choose to concentrate on solving this problem.

Mr. LANIGAN. You think this would indicate they are ahead in taking action to study nuclear physics?

Dr. WATERMAN. Yes.

Mr. LANIGAN. Ahead of this country at this time?

Dr. WATERMAN. As I will refer to a little later, they have a quicker system of making decisions than we do, and that is of great help.

But at the present time they have not got the background, frankly, in this accelerator game as thoroughly as we. So from reports we get, while their work is very good and they have an extremely competent number of young people, thoroughly trained and thoroughly knowledgeable about the field, their output of research to date has not shown the significance that ours has and they seem to be having more trouble with their big machines than we are. For example, from what we hear the 10 billion electronvolt machine is not producing as well as our 6; there is greater difficulty in its performing well enough to take good observations at the present time. Things like that where experience counts. But they will overcome that very soon because they have a very capable group.

THE PROPER PLACE OF GOVERNMENT IN SCIENTIFIC RESEARCH AND DEVELOPMENT

Is Government support necessary if the United States is to keep pace in the world of science?

It is becoming increasingly clear that a major responsibility of the Federal Government with respect to science is to see that both research and education in the sciences receives support, encouragement, and all necessary measures to maintain the scientific and technological power of the United States. A second responsibility is the adequate support of research and development necessary to the missions and specialized programs of the respective Federal agencies.

In general, research and development in support of agency missions has received the major share of the Federal Government's interest and support. In the Department of Defense and defense-related agencies particularly, the objectives of such research are readily identifiable and have been given priority of attention.

Until recently, the advancement of science generally and the effective training of our scientists and engineers has not been viewed as a major area of concern for the Federal Government. It is becoming increasingly clear, however, that we are in a race for technological supremacy and that our very survival may depend upon the high quality of our scientific effort. It is now beginning to be understood that the maintenance of technological preeminence depends fundamentally upon two important factors: full support of basic, long-term research, even though its ultimate application cannot be predicted, and the training of high-caliber students in science and technology in sufficient numbers to meet the needs. The time element is now so crucial that we can now no longer leave to chance the possibility that gifted students with aptitudes for science and technology will be identified, motivated toward those fields, and educated up to their highest skills. The upsurge in student population which will overwhelm our colleges and universities in the next decade will take so much attention, money, and effort that the problem of special attention to the gifted becomes a matter of major national concern.

It is obvious from relative population figures that the United States is outnumbered, and will continue to be outnumbered, by the Soviet Union. If we are to hold our own, therefore, we have no choice but to concentrate on quality. This means that there must be a radical change in our national attitude toward learning and toward teaching. The Federal Government must assume responsibility for what cannot

be done on a local basis, or cannot be done in time, in order to insure the high quality of teaching in all the fields of science, and to insure, also, that every needed step is taken to seek out and educate the gifted in all fields, and particularly in the technical fields where the training is longer and more exacting than in some others.

Mr. McCormack. Are there any questions?

Mr. Poland. May I ask one question, Mr. Chairman?

Mr. McCormack. Yes.

Mr. Poland. The emphasis here is on the time element. As I see it, the demand consists of three factors, the teachers, the students, and the ultimate production of scientists. How are you going to get those in step so as to get your time element to come out even?

Dr. Waterman. We must tackle those at the various levels, at the stages where they occur.

For instance, if we want gifted young scientists to become immediately available, we must provide measures which will obtain graduate students, help them get their degrees, and be available for jobs. We must see that our scientists have the basic training in research which is necessary. Then within the college itself, we must see that science is well taught, that the students are developed to their full capacity, and this goes back to the secondary schools, and probably to the elementary schools also.

This must eventually be attacked, it seems to me, at all these different stages.

Mr. McCormack. All right, Doctor, go ahead.

MAJOR AREAS OF DEFICIENCY IN FEDERAL EXPENDITURES IN FIELDS OF SCIENTIFIC RESEARCH AND DEVELOPMENT

Dr. Waterman. By all odds, the major area of deficiency in Federal Government expenditure for research and development at this time lies in the inadequate support of basic research and the facilities and equipment needed for basic research, especially by colleges and universities.

This is so for two reasons. One is that it is at the colleges and universities that the basic training is received, and the second is that it is at the colleges and universities where most basic research is done, and support of this makes for the progress of science.

I should like also to emphasize, Mr. Chairman, that I am not speaking now of the military situation alone. It is the economic situation which in the long run it seems to me is most important. Whether we have war or peace, the strength of the country has to depend on its science and technology, and this is the thing we must work for. This will give us the military strength and also the economic strength and vigor which is needed in any case.

According to the most recent issue of the foundation's annual study, Federal Funds for Science:

> More than 60 cents of every dollar for research and development is obligated for development; less than 40 cents for research, both basic and applied; and approximately 8 cents of the latter goes into basic research. In fiscal year 1957, total obligations for development amounted to $1.7 billion; for research, $964 million, of which only $218 million was obligated for basic research.

As I mentioned earlier, an important factor in the support of basic research is the increasing size, complexity, and consequent cost of equipment and facilities needed for basic research. Although such

major items as high-energy accelerators, nuclear reactors, and electronic computers have generally been provided by the Government for work to be done under contract, such equipment has been far less available to the universities for their own research programs and for the important function of training young scientists in the special techniques required by such modern instruments. The costs of such equipment run into the millions and hence are beyond the resources of most universities, or even groups of universities. Nevertheless, a number of universities have displayed a strong desire to acquire such instruments by supplementing Federal moneys and by pooling resources so that a major facility could be made available to all the universities within a given locality.

The Federal Government must be prepared to expand its support of the types of facilities mentioned, and to extend such support to include oceanographic vessels and special laboratories and field stations in polar, tropical, marine, and arid environments. The lack of such equipment and facilities in the very basic fields of the earth sciences is one reason why the United States research tends to lag behind that of other countries in those fields.

At this particular time, attention centers in the area where the United States conspicuously lags and that is the field of space technology. Although we have actively and brilliantly pursued upper-atmosphere research by means of high-altitude balloons, rockets, and combinations of the two, our satellite program of course has not yet materialized. The capabilities of the Soviets, as demonstrated by their performance in successfully launching two earth-circling satellites, open up whole new vistas for the future of space research and technology. Only a determined effort on our part, properly organized, with adequate funds, facilities, and competent manpower, can close this gap.

It would be a mistake to regard space research as primarily a military problem or to pace its progress with that of the missiles program. The earth satellite is a powerful new scientific instrument, capable at present of providing much needed data about the outer atmosphere and about the character of the earth and its environment as viewed from outside. From an instrumented earth satellite to a research observation platform in space is but one additional step. The scientific data that these instruments can furnish will provide much of the knowledge needed to determine whether space travel is feasible or valuable. The new knowledge to be gained through research with satellites and space rockets may and will in all probability have practical consequences of the same magnitude as those based on nuclear research.

Mr. McCormack. Are there any questions?

Mr. Jones. I have no questions.

Mr. Poland. I have no questions.

Mr. McCormack. Mr. Lanigan?

Mr. Lanigan. I have a couple of questions about the need for support of basic research and of facilities for basic research. I notice that the budget presentation of the President the other day said that there was about $140 million for the National Science Foundation. I wonder if you can tell us how much of that is to be available for basic research and basic research facilities?

Dr. WATERMAN. The division of our budget of $140 million, contained, I think, in the President's message, included $82 million for the purposes of training in science; $3 million of that was for the administrative expenses. The balance is divided between the support of basic research proper, which was $40 million in the regular budget, and our program for scientific information exchange and our survey program. For facilities, as I recall, it is $12 and a half million.

Mr. LANIGAN. I see. How did that compare with the amount that the National Science Foundation requested for these basic research projects?

Dr. WATERMAN. Our budget request came in the middle of the reconsideration period, following the news that we all know.

Mr. MCCORMACK. What was that reconsideration period?

Dr. WATERMAN. During the fall, following sputnik.

Our budget was determined just at the time when every effort was made to see what could be done about improving our support of research and training in science, so that our budget presentation involved discussions on, for example, what the Foundation should do in the matter of training and what should be done by the Office of Education, so it involved the necessary discussion with the Office of Education of the Department of Health, Education, and Welfare.

This resulted in complementary programs of the two agencies, whereas originally, before we knew what the Office of Education was going to do, ours was considerably larger in that area. It is not easy to make clear, because it has been the subject of considerable discussion.

Mr. LANIGAN. Did you submit a budget request to the Bureau of the Budget?

Dr. WATERMAN. Yes.

Mr. LANIGAN. How does that allow for basic research?

Dr. WATERMAN. If I recall this process correctly, the total was in the order of $240 million to start with, for a lot of training activities which later, when we learned the detail of the Office of Education program we cut back. I think that the facilities item was roughly half we asked, or something like that. The basic research was not much diminished.

We also may have $10 million for the supplemental budget.

Mr. LANIGAN. So the amount you received was about half of what the National Science Foundation thought it should expend for research facilities.

Dr. WATERMAN. On that particular item.

Mr. LANIGAN. And somewhat less, but not as much less, for supporting research activities?

Dr. WATERMAN. Yes.

Mr. LANIGAN. Now, what was the basis of the Science Foundation's request for, say, $25 million, or whatever it was, of research facilities? Did you feel that that was necessary to the carrying on of an adequate basic research program in the country?

Dr. WATERMAN. This, in our opinion, would be a desirable program, yes, and covered general facilities, largely for university use, as I have outlined here. Such things as astronomical facilities, high energy nuclear accelerator, reactors for research purposes, and large electronic computers. The plan would establish, depending on the

field in question, one facility or several in different parts of the country, which could be used by the universities.

Mr. LANIGAN. As a matter of fact, wasn't the research facility item cut down closer to two-thirds than one-half?

Dr. WATERMAN. I don't recall the exact figures, but I could look them up.

Mr. LANIGAN. Could you do that, and then we can put it in the record?

Dr. WATERMAN. Yes.

(NOTE.—Dr. Waterman subsequently supplied the following figures for the National Science Foundation's 1959 appropriation request for research facilities: Amount requested by the National Science Foundation was $32,170,000 and the amount requested in the President's budget was $12,400,000.)

Mr. LANIGAN. Do you feel there is a real need in the country, then, for more research facilities than you are asking for at this time?

Dr. WATERMAN. Yes, and some of them can be provided by other agencies, too, of course.

Mr. LANIGAN. When this cut was made, was it your understanding that other agencies were going to take up that slack, or is it just a cut that was made for budgetary purposes, in the research facilities?

Dr. WATERMAN. As always, in connection with our research programs, we are aware of what the interests of other agencies are, so the overall plan is the subject of a conference between us, and we know what we are doing.

Mr. LANIGAN. So you knew that when you asked for the original sum?

Dr. WATERMAN. Yes.

Mr. LANIGAN. When the Bureau of the Budget cuts an item such as this, do they specify where the cuts are to be made, or do they justify their cuts in any way to the agency?

Dr. WATERMAN. Well, we have never been pinned down too colsely on this. It is the area, rather than the specific item. This refers again to something I am going to talk to later. When one is speaking about facilities in advance, one wants to be able to have the funds in hand to start the facility when the plans are right to do it. This means that at the time you apply for funds, you may not know in detail exactly how much money is needed where as of that time.

You see, the funds differ in the amount needed for doing particular things, and the techniques for accomplishing these things change in the meantime.

Also, what we try to do, you see, is to do our best to meet a given need throughout the country, without specifying where or how we are going to actually carry out the individual items, so these are general, rather than specific, and we are not asked to pin them down that way.

Mr. LANIGAN. Does the Bureau of the Budget have scientists who approve your programs and evaluate them from the scientific standpoint, or are they evaluated solely from a fiscal standpoint?

Dr. WATERMAN. They have a staff which is expert in budget procedures.

Mr. MCCORMACK. They are scientists, though?

Dr. WATERMAN. They are not scientists; they are budget specialists, of course.

Mr. LANIGAN. Of course, in a total of $73 or $74 million budget, and extra dollars, twelve million five hundred, whatever your request was, would be just a drop in the bucket?

Dr. WATERMAN. In the overall budget, I would say yes.

Mr. LANIGAN. And did the Bureau of the Budget tell you why the cut was made?

Dr. WATERMAN. Yes, they give us the general principles that are involved in these cuts. Obviously, they have to be aware of the overall situation, which they alone can really consider. We have to admit that they are the authorities of what the country can afford overall, and must take into account their plans. So when they say a given item is——

Mr. MCCORMACK. You don't mean that the Bureau of the Budget are authorities over and above, in your field, the National Science Foundation, or in the field of labor, say, those who administer the laws?

Dr. WATERMAN. Oh, no. Let me make an analogy.

If one only has a certain amount of money to spend, whether a country or a concern, then one has to lay it out where it will do the most good.

Mr. MCCORMACK. I understand that, Doctor. But I think what Mr. Lanigan is trying to get at is—you asked for $240 million; did you?

Dr. WATERMAN. We asked for $147 million early in November. Then there was a general reconsideration within the administration and we were asked to take another look at the needs of scientific education. We then listed programs in education in the sciences requiring $240 million. It was then agreed that much of this could more appropriately be carried out by the Office of Education, that funds need only be supplied for 1 year for the teacher institutes instead of for 3 years, and that a particular program of present doubtful desirability for the Federal Government could be dropped. That was the first amount.

Mr. MCCORMACK. And you got $140 million?

Dr. WATERMAN. Yes.

Mr. MCCORMACK. Did they tell you that you get the $140 million, or did you sit around the table?

Dr. WATERMAN. Of course, we discuss these things with them, and then they came up with the figure which we are asked to approve.

Mr. MCCORMACK. They came up with the figure.

Dr. WATERMAN. With the final figure.

Mr. MCCORMACK. As I sit here now and ask you, do you know whether that figure will enable the National Science Foundation to carry out their program for the next year to the national interest and advancement of our country?

Dr. WATERMAN. We can do a good job on that figure; yes.

Mr. MCCORMACK. Then if you can do a good job on $140 million, why did you ask for $240 million?

Dr. WATERMAN. A good part of this reduction came out after discussion with the Office of Education. The rest were relatively minor. Our opinion of what we could do best is expressed in our request. But we can still do a very good job.

Mr. MCCORMACK. That is different from what you said before. I know that on $140 million you will do the best job you can, and having in mind the $140 million, you will do a good job. I can see that. But

do you think you can do as good a job for the country if you have $140 million as you could if you had $240 million?

Dr. WATERMAN. The $240 million does not enter the case, because, as I said, a large part of that was taken up by the Office of Education program. So we really are only talking about the small difference Mr. Lanigan mentioned.

Mr. LANIGAN. This was a cut of almost 50 percent, or more, in your research facility proposal.

Dr. WATERMAN. On that particular item.

Mr. LANIGAN. So that means you could have done twice as much as you can do with what you got?

Dr. WATERMAN. There is no doubt this was the best use we could think of for the funds we asked for. It is quite clear if we don't have as much, we can't do as much, of course.

Mr. LANIGAN. In the budgetary process, is there any way that you have in appeal from the decision of the Bureau of the Budget to the President, or to the President's science adviser, so as to get further consideration of the figures that you had asked for?

Dr. WATERMAN. Yes, this is always possible. I report to the President so this can be discussed with the White House.

Mr. LANIGAN. Did you take any sort of appeal in the case of this cut on research facilities?

Dr. WATERMAN. I would say there was nothing so formal as that about it. It was discussed by the three parties concerned all the way. There was no formal appeal in any sense, just an agreement.

Mr. LANIGAN. So you knew it was just decided on, and you had to abide by it.

Dr. WATERMAN. Yes, and we were party to the discussions.

Mr. MCCORMACK. All right, Doctor, go ahead.

Mr. JONES. May I ask one question before you leave this section?

Mr. MCCORMACK. All right.

Mr. JONES. Doctor, you said you regard space research—you say it would be a mistake to regard space research as primarily a military problem.

Now, are you satisfied that the military has done a good job of carrying on research and development, and that full use has been made of the technical know-how in research and capabilities in the last several years?

Dr. WATERMAN. Mr. Jones, this really goes beyond our responsibility in the Foundation. We are concerned to see that the quality of basic research is good. That, of course, is our major aim, but we don't get into the developmental programs.

Mr. JONES. Well, I understood that this outer space task or scientific mission was based upon the development of the missile itself.

Dr. WATERMAN. Yes.

Mr. JONES. From that missile, the satellite was developed?

Dr. WATERMAN. Yes.

Mr. JONES. Now, as I understand, we procured after the war, the know-how of the German scientists, and those Germans have not been given a proper role and mission to develop the missile program, which they stated repeatedly, both to the congressional committees and in speeches and other public utterances, that they could develop an outer space satellite or sputnik.

Now, are you satisfied that the military has fulfilled its role and mission in that field of scientific research that all the country has been disturbed and frustrated about?

Dr. WATERMAN. Well, of course, I, like everybody else, am disappointed that the United States didn't succeed in getting one there first. That goes without saying. As you know, this was the responsibility of the Department of Defense to develop the launching device and put the satellite in orbit.

Mr. JONES. Yes.

Dr. WATERMAN. Now, in the manner in which that was decided, it was put as a separate scientific development, as you know, and not part of the missile development for military purposes in defense. It, therefore, did not have the priority of the missile development that was there. As it turned out, we didn't get there first, but it is an excellent program——

Mr. JONES. Do you think we are going to be restricted in all of our scientific research to military accomplishments?

Dr. WATERMAN. No; but where you have 2 projects, 1 of which is military and 1 of which is scientific, and you have to decide on which gets priority, this depends on how you evaluate the situation as of that time.

It is customary to regard the military side as taking a very high priority indeed. Now, at the time, it was decided that the scientific part would not have the same priority as the military side, so it didn't develop as fast. This was the decision made at the time, and it seemed like a wise decision.

Mr. JONES. Do you think the roles and missions and proper assignments have been given to the military to proceed with our scientific work in order to provide some accomplishment in space work? Are you satisfied that that role and mission has been defined so clearly and specified to the various branches of the military service what they are going to do or what has been assigned them as to insure it will be accomplished?

Dr. WATERMAN. I believe they understand fully, and that the program as planned is going to be successful. I think that the outline, the assignment of the project, was clear.

Mr. JONES. When? When was it clear?

Dr. WATERMAN. As soon as it was assigned; when it was first announced by the White House, the assignment of the development of the launching vehicle.

Mr. JONES. Since sputnik?

Dr. WATERMAN. No; in 1955; our own Vanguard project. The assignment of our own development project was clear. It was laid down systematically. It was a good program.

Mr. JONES. Doctor, have you heard the various people, the scientists in various branches of the Government? Do you think they concur in your statement that their various missions were clearly defined to them, and their role and action was spelled out to them in what they were going to accomplish?

Dr. WATERMAN. This was clear to the branches of the military service that had the Vanguard to develop, which was the official launching device. To say that some other launching device might have done the job better is another thing. Perhaps that appears a mistake now, but I believe the decision was all right then.

Mr. JONES. The capabilities were there, whether they were employed or not, so you are not testifying to that proposition of what could have been done had there been other assignments made?

Dr. WATERMAN. That is right. And, at that time, we couldn't be sure of this. We decided the best way we could, then.

Mr. JONES. Let me ask you this question. It is rather frustrating to me. If the military knew they had scientists that could make this accomplishment, why did they not use those, instead of getting a new organization underway, one which they had some doubts about, or could have some doubts about?

Dr. WATERMAN. I think I can question that on these grounds: The Vanguard rocket, or rocket system, which was used for our satellite, was the logical development of a very skillful operation in the Navy, the research rocket named the Viking. There was a great deal of skill developed on this. That work was of a very high order.

Mr. JONES. And that assignment was given to the Navy?

Dr. WATERMAN. Yes, sir.

Mr. JONES. And what experience had they had, prior to that assignment, when it was placed in their hands?

Dr. WATERMAN. This was the experience I mean; their rocket program.

Mr. JONES. The Vanguard?

Dr. WATERMAN. No. The Viking rocket was the predecessor that the Navy developed. It was a research rocket, and so the satellite was a logical thing to do. They had great skill in this direction. I wouldn't question that.

Mr. JONES. Wasn't all the missile work done in this country a continuity of the work that had been done by the Nazis; it was a continuation of that program?

Dr. WATERMAN. It started back there; yes.

Mr. JONES. And that the people in Germany who had carried out that program, the German scientists, were procured and brought to this country and employed for the further research and development of that missile, and were not employed on the Vanguard or the first missile the Navy used?

Dr. WATERMAN. That is true.

Mr. JONES. Why do you suppose they abandoned the use of persons of proven capabilities to acquire the use of a group of people who had not had proven capabilities or previous experience?

Dr. WATERMAN. This is a question of priorities. If the military program had higher priorities, it was necessary to keep them on there.

Mr. JONES. That is what you keep saying here; that it is primarily a military problem. If it is a military problem, why haven't there been definitive statements made as to who was going to do what?

Dr. WATERMAN. I think this was entirely clear. The Navy got the satellite job, which was a scientific, not a military, project. They had people competent in experience with the Viking rocket.

Mr. JONES. Do you think that people who were employed on other similar tasks agree with your opinion?

Dr. WATERMAN. No. Judging by the papers, there are opinions on all sides of this.

Mr. JONES. That is all.

Mr. MCCORMACK. Mr. Lanigan?

Mr. LANIGAN. I want to get this budget picture straight. The amount you asked for research facilities, Dr. Waterman, was at least $25 million, and was cut back to about $12½ million?

Dr. WATERMAN. That is my recollection.

Mr. LANIGAN. The amount you asked for for research activities, the amount requested by the President, is $40 million, and—can you recall what the request was on that?

Dr. WATERMAN. I don't recall the exact figures. Of course, this was divided in that we have in the present budget $10 million for supplemental appropriation this year, which raises the total to 50. I forget what the other cut was exactly; it might have been 10 percent more.

Mr. LANIGAN. So that was about 10 percent more that you requested than what you got?

Dr. WATERMAN. Yes.

You see, one reason why this budget matter is not as clear-cut as you might think is that this is a larger request for the Foundation than in the past, and we have to balance its accomplishments against our capability for efficiently handling a large increase of this sort. We figure we can do it—but that is a consideration—and do it efficiently.

Mr. LANIGAN. What effect would you say that this cutback will have, if it remains, on the speeded-up research effort that seems to be needed in this country at this time? Does it make any difference, or do you think it will have an immediate and a long-term effect?

Dr. WATERMAN. This depends on whether some of the program can be picked up by other agencies, or whether, if they also get a cut, there isn't some way we can make provision for other sources of funds, either by joint action or some other way.

Mr. MCCORMACK. But the question is: Assuming no other agency is going to pick them up; what effect would that have?

Dr. WATERMAN. Well, our opinion was at the time, of course, that these were the needs as we saw them. If these needs cannot be met, then the effort can't go forward to the same degree. That is a matter of judgment, however.

Mr. MCCORMACK. Are there any further questions?

Mr. POLAND. One question on that.

If I understood the inference from your previous statement, the fields in which basic research is proceeding most slowly are those fields on which there is no apparent technological adaptation.

Dr. WATERMAN. Yes.

Mr. POLAND. Therefore, wouldn't it follow that the research facilities which you asked for for basic research would have to be done by the Government, because industry isn't doing them?

Dr. WATERMAN. In our field, yes in most cases.

Mr. POLAND. Then the cutting off of these basic research facilities would mean they weren't going to get done at all?

Dr. WATERMAN. We are not the only source, of course. The private foundations do this, and industry is taking more interest in it. They are doing so to some extent, and probably can do more.

Mr. POLAND. But when you make the request of the Budget, you made the request of the Budget for the increase in your facilities, the work would properly be done by the Government, and you have no present definite basis for coming to the conclusion that they are going to be picked up by somebody else?

Dr. WATERMAN. No.

But if they are important enough, there are ways in which the money can be found, probably, and we hope we and others can be of some assistance in securing it.

Mr. MCCORMACK. We are not cross-examining you, Doctor; we are trying to get information. All those contingencies are uncertain?

Dr. WATERMAN. Yes.

Mr. MCCORMACK. I would like to get the answer two ways, assuming that it didn't happen, and then, if certain things later happened, you could put it in the alternative, but that you would be able to evaluate it.

Dr. WATERMAN. I don't like to appear too vague in this, but there are variations. For example, in our program for support for facilities, Dr. Bronk can tell you, we hope for matching funds, or, if not, participating funds, from the institutions concerned.

Now, until we get down to business and decide on a particular project and where it might be, until we get requests, we can't be certain how much money they might raise. So there is an uncertainty which we can't avoid.

And since we are trying to plan in advance, we can't resolve these uncertainties at the present time. So it is not as clear-cut as a project for an ordinary piece of hardware.

Mr. MCCORMACK. Let me ask you questions in another field.

Most of this research done by private business is with Government funds; is that right?

Dr. WATERMAN. Most of which?

Mr. MCCORMACK. Most of the research work done is through Government funds, where there are contracts let?

Dr. WATERMAN. The total in the country?

Mr. MCCORMACK. Yes. I mean, wherever the Government makes a contract, and the Government's funds are involved.

Well, suppose as a result of the operation of the Government contract—it wouldn't apply so much to universities, I imagine—their scientists make some remarkable—some discovery.

Is there some way that that is reported to the National Science Foundation, or any other Government operation, so that it can be utilized if it is important?

Dr. WATERMAN. Yes.

Mr. MCCORMACK. To whom is that reported?

Dr. WATERMAN. To us.

Mr. MCCORMACK. Can that be utilized by other companies in connection with carrying out contracts?

Dr. WATERMAN. Oh, I beg your pardon.

If it is in our own program, it is reported to us. And, in general, if the Government has a contract with any firm or institution, any work which is done on that is immediately reported to the agency which is backing it.

Mr. MCCORMACK. But if a company should get a contract and, through considerable research involved, and it is Government funds, and some new discovery is made, something patented, or whatever you want to call it, that has to be reported to some agency of the Government?

Dr. WATERMAN. To the one that supports it.

Mr. MCCORMACK. Are you sure?

Dr. WATERMAN. I think that is required in every contract the Government makes, that this will be reported.

Mr. MCCORMACK. Then that can be utilized for the interests of our country?

Dr. WATERMAN. Exactly.

We have received copies——

Mr. MCCORMACK. Do you know anything about that, Dr. Bronk?

Dr. BRONK. I am not familiar with the present status of the whole patent policy, but I know that in every field I have been familiar with, that has been supported by Government contract or grant, the discoveries are available to the Government for such disposition as they may wish to make of them.

Dr. WATERMAN. Mr. Hoff could answer that. He is our General Counsel.

Mr. MCCORMACK. Would you give your full name, please?

Mr. HOFF. William Hoff.

In general, the Government has a royalty-free license to any invention, to any patents that come out of Government-sponsored research. That is the short answer. That doesn't mean that another company can use it for a commercial purpose. The company which secures the patent still has the proprietary right in it, except for Government purposes.

Mr. MCCORMACK. Well, now, you have given me information which I was seeking, and which is consistent with other information I have received. Where a company is a subcontractor for a prime contractor, it is told it can't let another prime contractor subcontractor know what progress it makes at Government expense.

That raises an interesting question, when you consider the national interest.

In other words, you are testifying that the company the Government has a contract within the field of science—makes some discovery of progress, if they are going to report it, as a general rule, they have to report it to the contracting agency. But that agency can't permit any competitor to use it. Is that right?

Mr. HOFF. That is right, except for governmental use.

Mr. MCCORMACK. You said except for governmental use?

Mr. HOFF. That is my understanding, that almost all Government contracts provide for a royalty-free license for governmental use. That would mean that for purposes of procurement by the Government, it could be used.

Mr. MCCORMACK. That will be an interesting field sometime to explore, but we won't go into it any further now.

Dr. WATERMAN. We don't get into the patent field very much, because basic research as a rule doesn't involve any patents. It results in just a published paper, and not a patent device.

Dr. BRONK. There is one aspect of the discussion which has just been going on which I hope you gentlemen will take into consideration. I don't know how you can be helpful, but I think it is important.

That is, that we should not fluctuate violently in our ideals and our objectives and our financial support. Research, like education, is something you can't do quickly for a brief time and then pull back again.

What we are scientifically and technologically as a country today was determined 10, 15, or 20 years ago. What we are doing today in

the field of education and basic research is going to determine where we are a decade or more from now.

One of the things that disturbs me a great deal is the fact that although a considerable number of people were calling attention to the fact that our support of basic research, our educational process, and our research facilities were not adequate for the last 10 or 15 years, it wasn't until the Russians came along and put that satellite up that the American people, educators as well as legislators and Government executives and industrialists, pricked up their ears and listened.

If now, for a period of time, we are going to have a great national enthusiasm for science and education and put support into them and then, as soon as we think we are sitting pretty again, we all drop back into complacency, we are not going to make good progress. It is going to be expensive.

What I am trying to say is I hope we develop the maturity as a Nation to set our ideals and objectives and to go forward with determination.

Mr. McCormack. I think that is a very excellent statement, and I think that everybody, legislators and public officials, and the public, agree with that statement. We may not have it as clear in our minds, some of us, as you have expressed it.

In other words, we shouldn't get stampeded. We should realize that we have brains here, and we have the capacity and ability, and we shouldn't get desperate, and what advances were made only 3 years ago in many respects are outmoded with the rapidity of change.

Dr. Bronk. I think a committee like yours can do a great deal to inject a sense of continuity and stability into our procedures.

These temptations to fluctuate violently with regard to the amount of money we spend cause a very uneconomical procedure. I have seen it happen in some industries, where they follow an enthusiastic approach and pour a lot of money in, and then as soon as it doesn't look very promising, they drop back. If it isn't worth supporting for an adequate time, it isn't worth going into at all in the first place.

Mr. McCormack. I know, but in order to carry that through, in the fields we are speaking of now, we have confined it to military research and development, because that is the immediate need facing our country, from the angle of preservation.

Isn't it necessary that research and development be given a position of standing, organizationally, where, on a top level, decisions can be made and the authority to carry out those decisions?

Dr. Bronk. I agree completely.

Mr. McCormack. Where is that level? Wouldn't it be as close to the President as possible?

Dr. Bronk. That is why I think it was such an admirable deed to bring in Dr. Killian as scientific adviser to the President, sitting right there.

Mr. McCormack. I agree with you, but his appointment is at the will of the President. What are his powers and his authority? The power to suggest, advise, recommend, is one thing. The power to make a decision is another thing and the authority to carry it out.

Dr. Bronk. I would say his authority is the authority of the President.

Mr. McCormack. I agree with you; if backed up. I am not saying it isn't. I have no knowledge.

And the President—he has virtually all the power; he has the primary power on the policy level and on the operating level, both as President and as Commander in Chief in an emergency. Is that right?

Dr. BRONK. Yes, sir.

Mr. MCCORMACK. But don't you think that Congress might consider legislation bringing research and development out of the level that it has occupied in the past, where it has to go through so many hands, and where the bottlenecks develop, as we know. We found that 4 years ago in this subcommittee when we looked into it.

And, at a level, say, comparable with the National Security Council under the President, responsible to the President, and having access to him, with the power to make decisions, and with the authority to carry them out.

Dr. BRONK. I have been quite close to Dr. Killian, and it is my strong impression that it is working very well. His position is working very well as it is now constituted.

Mr. MCCORMACK. I know Dr. Killian, and I am a great admirer of his. I have profound respect for him. He testified before this committee in 1954. I had talks with him prior thereto. Everything you say about him is absolutely correct. We could say more.

Again, the question of bringing research and development—putting it on a level where it has the power by law to make decisions and the authority to carry them out. Dr. Killian has whatever authority—he has all the authority of the President if the President confers it upon him and then backs him up. He has only such authority as the President wants to confer upon him and, also, back him up.

If he is in a supervisory level, and the operating level is going to continue down below the President at the White House level, there might be another individual in this development. I can see that.

Dr. BRONK. I think that we need a greater realization of the importance of science and technology, and a greater utilization of the scientific process, and the technological facilities all through the Government. I think this is coming.

I think that because science has become increasingly important to our national economy, security, and general welfare, there is a growing realization of this. I am firmly convinced that this will be more widely appreciated, and that scientists will be more effectively utilized all through Government, just as lawyers for years have been recognized as important to all branches of the Government, both legislative and executive, as well as in every administrative way. So I think this is coming in the field of science and technology.

Mr. MCCORMACK. But you both agree that research and science, together, should be on the top level where the decisions could be made by somebody—either some individual or a board or an agency or a council—with the authority to carry them out?

Dr. BRONK. At the top and the lower level.

Mr. MCCORMACK. Well, the top—I mean, there has to be a top level of power to make the decisions, with the power to carry them out. Carrying them out goes into the operating stage.

Is that a broad stage that would strike you?

Dr. WATERMAN. I would like to make one comment, Mr. Chairman, that one has to distinguish between science and technology again.

The technological side of the work done by the Government rests, naturally, with the agency which has a particular mission which is technological to some extent in nature, just as the Department of Defense has the responsibility for developing and manufacturing weapons, or devices of warfare.

This is a field in which they have had long experience, and they know their objectives, which are military. One can't, I think, dissociate responsibility for the development and production of military weapons from the Department of Defense.

The turn could hardly be called for all the agencies by a central one in such matters, because it is the agency itself on which one must put the responsibility for doing the best that can be done to get on with its mission. Science and technology are very important parts of that.

So, I would say that the authority for the development and the technology of a Government agency has to rest with that agency.

Mr. MCCORMACK. Then, the authority to carry it out, the roles could be assigned under the authority. There should be complete cooperation; of course, there should be. You can't separate the military, who has to execute, but we know what has happened in the past years.

The main difficulty, as I understand it, is on the management level.

Mr. JONES. Well, Mr. Chairman, that which the chairman has suggested ties in exactly with the proposition Dr. Bronk raised about the continuity of the program.

Unless there is a definitive action taken by the Executive in giving roles and missions, as the chairman suggests, there cannot be that continuity of what you would expect of a going scientific enterprise. That is the way I understand it, and the chairman.

Mr. MCCORMACK. My question of you was in the line of greater dignity and recognition of the importance in the world of today and tomorrow of science—not dominating our country; that would be the worst thing.

We can't eliminate the humanities and the other arts and sciences, but we know we are in the nuclear world.

As you say, you have a glimpse of it. If we get that, we have made a great advance.

We know the world of today is entirely different from the world of years ago. You know as well as I know that weapons that were effective 10 years ago are outmoded today.

Is that correct?

Dr. BRONK. Surely.

Mr. MCCORMACK. We are in a changing world, and we have to be in a position where we can meet the problems, because we have a potential enemy that is sinister, cold, evil minded. We have to realize that it is a battle for self-preservation.

Dr. BRONK. Science is woven through our whole civilization tion, through all of our Government, through all of our industry.

When people talk about the separation between the humanities and the sciences, I don't understand what they are talking about, because history for instance which is one of the humanities, is determined in no small part by science and technology.

As a scientist, I think of scientific endeavor as a great spiritual enterprise. It is a great adventure of the human mind.

Mr. McCormack. I am glad to hear you say that, and I admire you all the more because you come here to profess it publicly.

Are there any further questions?

(No response.)

Mr. McCormack. Doctor, you may continue.

Dr. Bronk. I just read a letter of Benjamin Franklin's last night coming down in a plane, and he said if there is one thing that the science of electricity has contributed more than anything else—I am paraphrasing him now, of course—it is that it makes a humble man.

Dr. Waterman. That is very true.

Mr. McCormack. You may continue, Doctor; I will be back in a minute.

THE EFFICIENCY AND ECONOMY OF THE ORGANIZATIONAL STRUCTURE THROUGH WHICH THE FEDERAL GOVERNMENT PLANS AND CONDUCTS ITS RESEARCH AND DEVELOPMENT ACTIVITIES, INCLUDING A DESCRIPTION, THE AGENCIES WHICH ARE INVOLVED, AND THE MAJOR RELATIONSHIPS AMONG THEM

Dr. Waterman. The organization, planning, and conduct of research and development by the Federal Government is a large and complex problem, requiring continual examination and review in the interest of balance, adequacy, and coordination. Part of the problem stems from the size of the operation.

The estimated level of Federal expenditures for research and development in fiscal year 1957 was $2.8 billion, an amount far in excess of any comparable effort by private industry.

Another part of the problem stems from the wide diversity in the scientific activities being supported by the various agencies of the Federal Government. Some 23 departments, offices, agencies and establishments of the executive branch of the Federal Government administer funds for scientific research and development.

In fiscal year 1957, the Department of Defense and the Atomic Energy Commission together accounted for 85 percent of the total funds.

Other agencies with substantial research and development programs include the Department of Health, Education, and Welfare, Department of Agriculture, National Advisory Committee for Aeronautics, Department of the Interior, Department of Commerce, and National Science Foundation. The other 15 agencies account for the remaining 1 percent of the total obligations.

The major programs of the agencies enumerated evolved over different periods of time, with differing objectives and procedures. It is therefore difficult, if not impossible, to apply a common yardstick against which the programs of all the agencies could be rated in all respects in terms of efficiency and economy.

For example, the problems of administering an agricultural research program, through the State experiment stations, or administering a grants program for basic research in the colleges and universities, are so different from the problems of administering an intercontinental ballistic missile program that it is quite impracticable to attempt a comparison except in the very broadest terms.

By the same token the establishment of a single department of science and technology, far from providing a solution to the innumerable and widely differing problems inherent in the overall Federal research and development program, would create additional problems.

Many of the problems of this type which require attention may now be handled by the special assistant to the President for science and technology, Dr. Killian, and especially with the advice of his Science Advisory Committee.

Despite the differences in the various governmental research and development programs, however, there is good coordination and understanding among them.

One thing that all research and development programs have in common is scientists; and scientists are thoroughly accustomed to working cooperatively and to keeping themselves informed of what is going on in their own and in related fields. Failure to do so is to commit professional suicide.

Except where security provisions are involved, scientists exchange information on their work in the Government as they do on the outside and with the outside; they publish in the same journals; they attend the same meetings. In addition, other measures designed to bring about a more formal exchange of information have been instituted.

The Interdepartmental Committee on Scientific Research and Development, consisting of the directors of research in all the agencies with major scientific research and development programs, affords a forum for consideration of common problems such as administration, personnel and scientific information exchange.

The research and development activities of the Department of Defense and the National Advisory Committee for Aeronautics are closely coordinated in order to avoid undesirable overlap in their developmental activity. Similar coordination is effected among the National Institutes of Health, the Atomic Energy Commission, and the Department of Defense in the fields of medical research.

The Foundation maintains a central register of basic research projects being supported with Federal funds, outside the Federal Government itself, in the life sciences, social sciences, and the mathematical, physical, and engineering sciences. These records are compiled and published at regular intervals so that each agency may have the opportunity to review what is being done by other agencies in the same field.

Those agencies that are supporting basic research maintain informal working relationships with other agencies so that action by one agency on an application for support is promptly known by others in the same field.

The functions of all the agencies that conduct or support scientific research and development are too extensive and too detailed to be outlined here.

These informal working relationships exist between those who are planning and administering programs in research, who are in the same fields, such as physics, chemistry, and biology, and this is one of the more fruitful ways of achieving coordination. So, each agency knows what is being undertaken by another in the field of science. And in this way, we have a good knowledge at any given time of what the total Federal program is.

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The National Science Foundation has compiled a directory entitled "Organization of the Federal Government for Scientific Activities." This document covers 347 pages and is accompanied by organization charts and general descriptions of the scientific activities of all the agencies involved. It will no doubt come as a surprise to many Americans to realize that the Federal research and development effort is so extensive and diversified.

In stressing the scope and diversity of the Federal research and development program, I should not wish, however, to create the impression that there are no common problems or procedures, and especially that there is not room for improvement in these. Certainly, there are many such areas that would repay careful examination and attention.

One procedure that all agencies have in common is the budget process. Speaking as one who is not an expert in the comparative practices of the several nations, I may nevertheless venture a few remarks comparing the United States with other systems. In this country, each department and agency of the executive branch, after much study and planning by all units involved, presents its proposed budget for the coming fiscal year to the Bureau of the Budget for thorough examination and review, both in terms of its relation to the requesting agency and to the President's overall budget. After the agencies' budgets receive the approval of the Bureau of the Budget on behalf of the President, they are defended by the agencies before the two houses of Congress and are thus subject once again to careful examination and review. The entire process engages the attention of a significant portion of each agency staff for a period of about a year and a half for each budget, with the exception of supplementary budgets. This system is probably more thorough than that of other large governments. It is also probably the most protracted. Its chief drawback is the time lag between the initiation of plans and the receipt of funds for carrying them out. Under most other systems, as I understand it, the budget is prepared by the department in consultation with the government, and the whole process is accomplished in one step. The government's budget is not a matter for review and debate in such a system, unless indeed the government is challenged and falls.

Although we do not know the details of the Soviet system, some idea of its effectiveness with respect to matters of high priority may be inferred from a conversation between the head of the Russian high-energy nuclear accelerator project and one of our nuclear scientists attending the International Conference on "Atoms for Peace." When the Soviet scientist was asked what arrangements were made for the money to carry on his work, he replied that he and his group were not involved in fiscal matters, but had merely to state their needs and construction of the accelerator began at once. Other American scientists returning from meetings in Moscow report that Soviet scientists appeared to be under no obligation to economize, as the Russian equipment was constructed of the finest material available and quite obviously no expense had been spared. Under this system, research projects that enjoy a high priority would be expected to get underway a year earlier than would otherwise be the case.

The whole budgetary process is a matter of particular importance and concern for basic research in science because such research in-

volves the exploration of the unknown. Projects in this area cannot be clearly justified in terms of the specific promise of results. Obviously, no one can foresee before the research begins what the results will be or how significant they may ultimately become. Therefore, funding for this type of research is subject to a very considerable handicap in competition with funds for specific practical purposes, the nature of which is well understood.

Perhaps a good way of illustrating this, Mr. Chairman, is from history, since we can't predict. What happens, of course, is that out of basic research comes a very promising discovery which, at the moment, is very fundamental in science, and one doesn't see what can happen next. Then gradually, as this discovery comes into other hands, it goes over into the area where one can foresee the practical development, so it is only years later that the full appreciation is understood.

One illustration of this would be the Einstein equation, which is at the very basis of nuclear energy. This equation: $E=mc^2$. What that meant was that matter, mass, or an object possessing weight has the possibility of being transformed into energy. But Einstein himself, at the time, when he was asked, said he saw no possible way that this could be used.

Then, a quarter of a century later, with the appearance of atomic fission, it became evident that here was a case where matter could be transformed into energy and made useful.

Another good illustration which shows the international character of these things is the discovery made by the British theoretical physicist, Clerk Maxwell, on the basis of mathematical equations concerning electricity in the middle of the last century. He saw that there was something in his equations which corresponded to speed or velocity. That led him to predict there was such a thing as a radio wave that could travel through space.

About 20 years later, a German, Heinrich Hertz, set up in his laboratory an experiment that showed these waves exist and could be made. This, of course, was taken into hand by an Italian, Marconi, and, with the application of the electron tube by our own DeForest, we got into broadcasting and electronics and all the rest of it.

The fact that only through scientific research do we have the possibility of making these advances is obvious.

Because of the nature of the budgetary and appropriations processes, it is difficult to make funds available for the prompt support of sudden, unexpected developments whose pursuit seems indicated in the national interest. In view of the rapid pace of modern science and technology, 18 months or 2 years could well prove too long a period in which to wait before moving into a given area. It would be advantageous to have some sound way of dealing with this problem. Likewise, it may be pointed out that basic research requires continuity and stability of support, otherwise valuable momentum and key personnel are lost.

Mr. McCormack. Any questions?

Mr. Lanigan. Have you seen the press release by the chairman of this committee, Congressman Dawson, and his proposal to set up $200 million scientific research reserve fund which you may utilize?

Dr. Waterman. Yes.

Mr. LANIGAN. I wonder if we can put that in the record at this point?

Mr. MCCORMACK. Without objection, it is so ordered.

(The document referred to is as follows:)

[Press release, for release Sunday, January 12, 1958]

A $200 MILLION SCIENTIFIC RESEARCH RESERVE FUND PROPOSED BY CONGRESSMAN WILLIAM L. DAWSON, CHAIRMAN, HOUSE GOVERNMENT OPERATIONS COMMITTEE

Congressman William L. Dawson (Democrat, of Illinois), chairman of the House Committee on Government Operations, proposed Saturday that a $200 million scientific research reserve fund be established to permit highly desirable and carefully selected scientific basic and applied research projects to be started or to be continued without the lengthy delays usually involved in securing the approval of, and appropriations for such projects.

Congressman Dawson stated that preliminary studies of the Federal agencies' budgeting and organization for carrying on scientific research and development revealed that one of the serious problems in the field is the lag between the time when an important research project is conceived and the time it can actually be commenced. In many cases various types of Government redtape result in a 2- to 10-year lag. A similar problem arises when a research project approaches a breakthrough stage but money is not available to push it through or when the continuity of an important project is otherwise threatened because of lack of funds.

Under the Dawson proposal a continuing fund of $200 million would be established and made available for disbursement by a vote of a group of the leading and most respected scientists in the Nation, men in whom Congress would have the utmost confidence. Mr. Dawson indicated that a panel of the National Science Board, which sets the policies of the National Science Foundation, would probably participate in approving the disbursements. Mr. Dawson stated that the plan has been endorsed in principle by some of the Nation's leading scientists. It will undoubtedly be considered in connection with previously announced committee hearings commencing on January 15, 1958, with the appearance of Dr. Detlev W. Bronk, President of the National Academy of Science, and Dr. Alan Waterman, Director of the National Science Foundation.

Under the plan, the democratic processes would be preserved by having the Board report to Congress annually on its expenditures, on the projects authorized, and on the results attained. Congress would then, under the proposal, appropriate moneys to restore the fund to its authorized level. Moneys placed in the fund would be available until expended.

Congressman Dawson raised the possibility that the fund might in time become partially self-supporting by assigning to it the moneys received by the Government as the result of projects financed by the fund.

Mr. Dawson emphasized (1) that the plan contemplated that the fund would be available for all types of scientific basic and applied research projects whether or not directly and immediately related to military activities, and (2) that the fund would supplement, not replace, existing agency budgets which are developed through the more time-consuming budgeting processes.

Mr. LANIGAN. Do you believe that approach could be used to help some of this problem of time lag and also of continuity? Have you given it any thought?

Dr. WATERMAN. Yes; I have. It does need careful consideration. My first thought is that it would be difficult to see how a centrally managed fund could operate in projects involving development. As I stated earlier, I firmly believe that the development and technological matters should be the responsibility of the individual agencies.

Mr. LANIGAN. I don't know what form you saw it in, but as the proposal was put out, it was limited to research and not to development.

Dr. WATERMAN. If this central fund was not subject to competition for practical objectives in the hands of various agencies and if it

was restricted to basic research, then I think this is a very interesting idea.

Mr. JONES. You mean you do not want to divorce it from the functional operation of an agency?

Dr. WATERMAN. That is correct. Each agency should have its operation clearly outlined, and funds for that purpose. If individual agencies were to compete for a central fund, this would be undesirable. If it were for use within an agency itself, then, it would be an interesting thing to consider. If it were in basic science, I would think it would not need to be as large a sum as this, and perhaps it would be advantageous to try it as an experiment with a smaller sum. It could be quite useful in the matter of equipment, for example, for research facilities as they are needed.

Mr. MCCORMACK. Are there any further questions?

Dr. WATERMAN. Have you any comment on that, Dr. Bronk?

Dr. BRONK. I think it would be a very helpful thing. It would give continuity, to which we have just been speaking. I think it would be important to have the individuals or the agency or the agencies responsible for its expenditure very carefully considered.

If there were going to be representatives of various agencies on the board, authorizing expenditure from it, I can conceive of its being used as a pork barrel for all sorts of purposes.

Mr. LANIGAN. Well, under the proposal that was put out, it was a proposal for the National Science Board, of which you are the Chairman, or a panel of that Board, being the body which would authorize disbursements from the fund.

Dr. BRONK. The way I saw it, they would be represented.

Mr. LANIGAN. They would be included.

Dr. BRONK. Then, if you have various agencies represented, how are you going to avoid their trying to supplement their normal budgets by saying: "We can reach in here."

Then the Chairman of this Board spending $200 million would have to be a very good tactician.

Mr. LANIGAN. If it were the National Science Board——

Dr. BRONK. We would do it very well. I can see we would be under pressure from some agencies to fish them out of their fiscal difficulties.

Mr. MCCORMACK. Are there any further questions?

(No response.)

Mr. MCCORMACK. All right, Doctor.

Dr. BRONK. I noticed in Dr. Waterman's prepared testimony here a thing that I can't resist commenting on.

American scientists returning from meetings in Moscow report that Soviet scientists do not need to economize; that no expense is being spared to make them as efficient and advanced as possible.

I can't avoid saying that I have an idea that the Russian people, generally, have to economize in a lot of ways, and also are denied a lot of things that are very precious to the free life.

Mr. MCCORMACK. That is very evident.

Dr. WATERMAN. Things of low priority are another matter entirely.

Mr. MCCORMACK. We won't be able to get through tonight with you, Doctor. I see there are 12 more pages, and it is now 4:30.

The next subdivision, 7, covers some 11 pages.

May I ask that you and Dr. Bronk continue with us tomorrow at 10 o'clock. We had you scheduled for today and tomorow.

Mr. POLAND. Bear in mind that that is room 1501 tomorrow, New House Office Building.

Mr. MCCORMACK. We are recessed until tomorrow morning at 10 o'clock, in room 1501, New House Office Building.

(Whereupon, at 4:30 p. m., the subcommittee recessed to reconvene at 10 a. m., Thursday, January 16, 1958, in room 1501, New House Office Building.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

THURSDAY, JANUARY 16, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND LEGISLATIVE REORGANIZATION OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1501, New House Office Building, Hon. John W. McCormack presiding.

Present: Representatives McCormack (presiding), Jones, Fascell, and Mrs. Harden.

Also present: Orville S. Poland, general counsel to the committee, James A. Lanigan, associate general counsel; William A. Young, staff consultant, and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK (presiding). The subcommittee will come to order.

Dr. Waterman, we were on page 21; were we not?

Dr. WATERMAN. Page 21, I believe.

Mr. MCCORMACK. All right, you may proceed.

FURTHER STATEMENT OF DR. ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION; ACCOMPANIED BY DR. DETLEV W. BRONK, PRESIDENT, NATIONAL ACADEMY OF SCIENCES, AND CHAIRMAN, NATIONAL SCIENCE BOARD; AND WILLIAM HOFF, GENERAL COUNSEL, NATIONAL SCIENCE FOUNDATION

THE RELATIVE EFFICIENCY AND ECONOMY INVOLVED IN CONDUCTING SCIENTIFIC RESEARCH AND DEVELOPMENT THROUGH GOVERNMENT FACILITIES, UNIVERSITIES, OTHER NONPROFIT ORGANIZATIONS AND PRIVATE CONTRACTORS

Dr. WATERMAN. In attempting to evaluate the relative efficiency and economy of the various methods by which scientific research and development is conducted under Government auspices, one must first of all understand something of the circumstances under which each method is used.

The rapid growth of research and development needs by the Federal Government in the period following World War II has resulted in a changing pattern by which such research is accomplished.

As I mentioned previously, prior to World War II, most federally supported research and development was performed in Government laboratories by Government personnel. Notable examples were the military laboratories, the public health laboratories, the laboratories maintained by the NACA, including subsonic and supersonic wind

tunnels, and the scientific establishments of the Department of Agriculture, the National Bureau of Standards, United States Weather Bureau, and the Bureau of Mines.

During World War II, when there was clearly no time to expand existing laboratories or to construct new ones under Government auspices to meet the emergency, the research and development contract came into widespread use. This type of contract was awarded both to industrial concerns and to colleges, universities, and nonprofit research institutes. This device proved so successful during the war that its use was continued and extended in the postwar period.

Coinciding with the growth of the research and development contractual procedure was the gradual evolution of the research center and the national laboratory. I might make a word of distinction here. The research center is really what the new growth was. The national laboratories I regard as research centers, too, but the national laboratory, as the name implies, is open to anyone in the country who is competent to do research, whereas the research center may be specifically, and usually is, in a narrow sense, a contractual method of dealing with a particular research and development problem, which may be a broad one. The two, however, may be nearly the same thing and are the same thing in their manner of arrangement which is by contract with some organization.

This type of institution came into being originally because several of the universities operating under the large-scale research and development contracts felt it necessary to segregate Government work for reasons of security, and also because staffing and administration problems differed markedly from those normally employed by the university in the conduct of its own affairs.

Such laboratories included the radiation laboratory at MIT, during the war; the applied physics laboratory of John Hopkins University; the Allegheny ballistics laboratory of the George Washington University; the Los Alamos scientific laboratory, administered by the University of California; and the Argonne National Laboratory, administered by the University of Chicago.

The national laboratories have achieved outstanding success. In some cases special associations of universities have been formed for their management, as for example, Associated Universities, Inc. (for the operation of the Brookhaven Laboratory and for the construction of the National Radio Astronomy Observatory), and the Associated Universities for Research in Astronomy (for the establishment and operation of a new national astronomical observatory in the Southwest).

With these several methods available for the performance of needed research and development, the Government departments with research and development programs have a choice as to which method shall be used. There are advantages and disadvantages inherent in each.

Generally speaking, the Government-owned and operated laboratory has the advantage of performance and closer incorporation within the Federal structure, which are associated with a continuing need in fields of research and development for which there is no commercial interest and which may be unsuitable for an academic environment.

The research and development contract is widely used for large and small projects. I discussed that somewhat earlier. Its advan-

tages are clearly the speed with which action can be taken to proceed with research and development along lines with which the contractor has available high competence and experience.

The national laboratory has the advantage of general access to competent research personnel across the country, especially from colleges and universities.

The research center, when established in conjunction with an academic institution, which is devoted to a particular purpose, is in an environment where the broad background and experience of the academic faculty of the institution may be brought to bear in a convenient consulting manner, as well as high competence in the direction of research projects. Historically, several of the research centers developed out of an existing nucleus of talent, as was the case with the radiation laboratory at MIT. The Los Alamos scientific laboratory originated in the special facilities of the University of California physics department, which had on its faculty, among others, Ernest Lawrence and J. Robert Oppenheimer.

Project Lincoln was placed at MIT, where high competence in management of research and development existed and where there were also excellent facilities for engineering and electronic research and high-speed computation for background.

Where speed and flexibility have been prime considerations, it has been natural for the Federal departments and agencies to contract for an existing research center rather than to expand or to develop new laboratories of their own. This has been particularly true in the case of the newer departments—the Atomic Energy Commission, created in 1946, and the Air Force, in 1947.

One may not generalize and state categorically that any one of the foregoing methods is more efficient or more economical than the other; for if sound judgment is used, we may assume that the method chosen is probably the best in a given situation.

We must recognize that the pattern of Federal research and development activities is a highly dynamic one, and that even as new challenges and new problems arise, so, too, we must be prepared to evolve new devices and techniques for meeting them.

Before leaving the subject, however, I should mention that the wide differences in personnel and administrative procedures employed by the Federal Government, private industry, and academic institutions are a complicating factor that necessarily influence the choice of method.

Government establishments unquestionably suffer from the fact that the ceiling on the salaries available to scientists and engineers is markedly lower than salaries for comparable work in private industry. This fact makes it difficult for the Government to recruit and holding its own laboratories the scientists and engineers it needs, particularly at a time when these are very much in demand by private industry.

Colleges and universities labor under personnel difficulties similar to those of the Federal Government as an employer, and sometimes in the smaller institutions the situation is acute.

However, the salary problem is offset to some extent by the freedom for research, which is greater in general than in industry or government, and the added attraction of research that is associated with teaching. A recent study by Fortune shows that a preponderance of

brilliant young American scientists prefer the universities to industry because of appeal of academic life.

Nevertheless, effort should be made to establish better equilibrium in the salaries for scientists and engineers, in these different categories, in order that the Government may be able to acquire the staff that it needs, and in order that universities may not be raided of their teachers and high quality scientists.

The foregoing discussion relates primarily to the type of research and development for which the Government itself has a definite need. In all such cases, the Government presumably takes the initiative in seeking out the method best suited to the problem at hand.

An entirely different set of considerations apply to the support of basic research where the Government's interest is the increase of knowledge, progress of science, rather than the solution of a specific problem.

The experience of departments and agencies supporting that type of research has been that the research grant offers the most satisfactory instrument for the purpose. Infact, many features of the research grant have worked out so satisfactorily in practice that the National Science Foundation has been moved to recommend that some of these, notably the provisions with respect to the accountability for property, be substituted for less workable provisions in the research contract.

Mr. McCormack. Are there any questions, Mrs. Harden?

Mrs. Harden. No questions.

Mr. McCormack. Any by the staff?

Mr. Poland. Do you care to comment in this connection, on the role of scientists, which is, maybe, a dual role, first, the need for basic research in the areas where the exploration is to be made, and then, second, their role as one to pursue that research under a directive or a grant made by the Foundation?

Dr. Waterman. The ideas for research necessarily come from the scientists themselves, if one is thinking about the progress of science itself. You remember I make a distinction there.

In case research is needed by the Federal Govrnment to support the mission of a given agency, then the initiative comes from the agency to get the work done.

But if one is talking about making research progress in science, that I stressed so strongly here, then the intiative has really to come from the scientists themselves. So that they are the best ones to judge.

What at a given time seems important to them changes from time to time because research is very much of a dynamic thing.

So the best way to consider how to meet the progress in science in these fields is to offer a clear opportunity to any scientist to apply for the aid he needs, and then have that problem reviewed by his peers in the same field to make certain that they, too, regard this as important. So that one weighs the requests one receives in various fields and is able to pick out those within the budget that is available, that can be supported by that budget.

Does that answer your question?

Mr. Poland. I think it does. That leads me to the question of whether your source material in respect to basic research, extending the boundaries of scientific knowledge, does not come from the scientists themselves rather than originating within the Foundation.

Dr. WATERMAN. Our technique in support of basic research in the Foundation and in other Federal agencies consists in making it known that any scientist, or group of scientists in the country that have a problem they regard as important, so that then they can apply for assistance.

Normally, they do this through their institutions so as to get the indorsement of their institution. And then when the money is furnished to them it is done not directly to them, but either by grant or by contract to the institution for them, so it is earmarked for the project which they have. But it goes to the institution under which they are working.

Mr. POLAND. With a proportion of that for the institution as overhead?

Dr. WATERMAN. Yes.

Mr. MCCORMACK. Are there any further questions?

Mr. LANIGAN. To what extent would you say the Government is affected by the fact when it pays for these research contracts and pays the research grants and in turn the grantees and the contractors hire employees, scientists, at higher rates than the Government does, so you have the Government paying indirectly higher salaries than are paid to its own employees directly?

Do you think that is a serious problem?

Dr. WATERMAN. That is not a serious problem in basic research because those people are generally supported, you see, at nonprofit institutions such as universities, and there the salaries are generally not higher than the Government.

Mr. LANIGAN. I can think of three acquaintances of mine classified as scientists, two of whom were in basic research, one at Johns Hopkins and one at a Government institution, but now have switched over to applied research and development because in each case an aircraft company was able to pay them more money than the Government. But still, the money that is being paid to them is in effect being paid to the aircraft company by the Government. It took them from basic to applied research and gave them more money.

It had two effects.

Is that a serious problem, the switchover of people from basic science to other types of activity?

Dr. WATERMAN. It is all the more reason—and a very important thing—why we have to watch out for basic research. Because, applied research, as you say, is more likely to get funds in the first place, because it has a clear-cut aim that people can see and recognize as being important, whereas basic research seems vague and unsure.

And in the second place, because of its high standing, especially in industry, the salaries paid to people working in applied research and development is greater.

On both counts, therefore, we have to watch out if we are going to have a well-balanced program in the country that we do pay special attention to basic research.

Dr. Bush put it very well years ago in a very simple statement. He said, "Applied research drives out basic."

Mr. MCCORMACK. Are there any further questions?

Mr. JONES. You say "watch out." What do you mean by "watch out"? What can we do to arrest that kind of situation?

Dr. WATERMAN. Make sure that everyone understands the importance of basic research which has less closely defined goals and the outcome of which is uncertain. But that is, also, very important. And it is important for just these reasons, that one cannot see for sure what it will produce. And then because the salaries are greater and inducements are greater on the applied side.

Mr. JONES. That is along the line of questioning I made inquiry on yesterday. And invariably it has been my observation when we come to that question, the answer to it is "get more money and more money."

So we are in circles of getting more money.

Actually, it seems to me that just is not going to be the answer, just getting somebody some more money.

To give them an opportunity to exercise or to pursue the vision and the imagination—that is the thing that we want.

Dr. WATERMAN. That is it exactly. Very often, as we see these applications for research grants come in, they only ask for things they need in general. Sometimes this is only for personal assistance for a graduate student to help him in his work. This is very common in mathematics.

In other cases it is only for a particular instrument.

Mr. JONES. Are you satisfied, Doctor, that the major industries of this country when they do go in and ask for employees, researchers and take them out at higher pay are doing a discredit to those research activities that are done for national defense and for security—are they bringing impairment to that by doing so?

Dr. WATERMAN. It depends on how one views national security, whether in the long or short run.

If industry goes to the university on a critical defense job which the Government has asked them to do and tries to get the best men they can, this is only natural because it is a defense job and may be critically important.

As I say, this is a hard thing to judge.

Suppose the man they ask for is an outstanding basic research man in the university and also doing teaching. He is making a great contribution where he is in the training of scientists and in the progress of science. How do you weigh that against a critical national need? I don't know how one answers that except that if the national need is very great and it is a military defense problem, then arrangements could be made to get the man temporarily on this while it lasts, and then have him go back to his job in the university.

But you have posed here a very tough question to decide.

Mr. JONES. I have seen from some personnel reports in activities of the Federal Government that the turnover was relatively small, I think, 1.98 percent, as compared with about 4 percent of the overall turnover in Federal employment.

Is it the opportunity for academic accomplishment that attracts them and keeps them to their posts?

Dr. WATERMAN. Yes; in general, that is true. A scientist, when he gets into advanced work, wants to accomplish something original in research. Wherever he goes, this is foremost in his mind.

Mr. JONES. I know of some military scientific research tasks that have been assigned to certain branches of the service that they spend a great deal of time going out like the football team rooting for the

quarterback and making solicitations, and they tell me that, invariably, when they go to the college to seek the fresh new minds, the fellow there from the large corporations is able to get them, and they have to take what is left over.

Dr. WATERMAN. That is often true. Industry has the advantage here because they can offer large salaries.

Mr. JONES. Do you think that is going to continue to occur to the extent that it will bring some harm to the national effort?

Dr. WATERMAN. It can.

Mr. JONES. Do you have any suggestions to remedy that situation, to make sure that these tasks and missions are accomplished by having good personnel to do that work, both in what you call basic and applied research?

Dr. WATERMAN. Yes. Well, there are several moves here. It is a pretty broad question and needs some careful thought. Several things are important. In order to protect the research worker at the university, if he is making a great contribution to his field and to the training of scientists, it would certainly be helpful for the university to have higher salaries so that the man can, at least, be comfortable. Salary is not the major factor to him. One would never expect there would be very high pay. But, if he has a comfortable salary to take care of himself and his family, then the incentive to work in the university will probably be sufficient to keep him there; that is, in the cases of most individuals.

In the case of the Government scientist, there is a need that higher salaries can be paid than at present because the ceiling is low.

Put it this way: Work in Government laboratories is so nearly similar to work in industrial laboratories that it becomes very easy for a man to move from a Government laboratory to an industrial laboratory. The environment may be nearly the same. So there the salary is a much more important consideration.

Of course, the Government laboratory has certain advantages, security of position, and if the man is dedicated in his interest in national problems, as many of them are, you cannot get him to move. But, if Government salaries for scientists and research people could be increased, this would remedy the situation considerably.

Another reason which upsets the equilibrium at the present time is because the Government itself demands high performance from industry on many national problems. And so, in order to meet the conditions of their contracts, they do have to search out the best people they can get, which is perfectly legitimate. So, the Government itself, you might say, to the extent that it makes contracts on national problems with industry, is offering a chance for competition with its own laboratories.

There is a way out here. I mentioned it earlier. That is if, in doing so, the Government puts a limit on the salaries of people who are paid under Government contracts, that tends to protect the Government laboratory, although I think the healthier thing, myself, is to increase the salaries of Government employees and make them more comparable. That is a positive thing; the other is a negative thing.

Mr. MCCORMACK. Are there any further questions?

Dr. BRONK. I think one of the things to bear in mind is the matter we discussed yesterday afternoon; that is, the whole attitude of our Nation toward certain types of activities.

There are these intangible elements of prestige, of the recognized significance of one type of activity or another. Let me give you an example. Quite a few years ago, I was a professor at one of our leading small colleges. I had a young man who was a student there who was trying to decide whether he would go into an academic career or go into business. I happened to be in his father's office one afternoon. He was president of one of the large organizations in Philadelphia.

When I came out, I went back to my office, and the contrast between his office and mine was quite spectacular. That evening I was having dinner with the president of the college and he said, "How is young Howard coming with his decision?"

I said, "If young Howard decides to go into the academic career, after the contrast I have seen this afternoon, I do not think he is very smart. His father's office indicates the prestige which America gives to a person in business. If he goes into my dingy, shabby office, he cannot help but be impressed by the fact that America does not respect the academic career."

The boy went into business.

This is not the only thing which draws them one way or another. But I think we would be unrealistic if we did not recognize the fact that there are these intangible lures one way or another. We have to decide what we want as a nation of free people.

Mr. McCormack. Mr. Fascell.

Mr. Fascell. I was pleased to hear Dr. Bronk address himself to the question of emphasis, because I think this is the root of the problem. As I understand Dr. Waterman, our fundamental difficulty is basic research; is that correct, from the scientific standpoint? And this becomes a question of emphasis. Would you agree with the statement that was made by Dr. Furnas not too long ago when he was head of research and development of the Defense Department, that he was directed and instructed to deemphasize basic research as an unnecessary luxury, something that the military absolutely could not afford and did not want?

Dr. Furnas said this is a big error on the part of the Government.

Dr. Waterman. I think so. The Government should, certainly, support basic research strongly.

Mr. Fascell. This is one of the ways in which we can emphasize, or change the emphasis that now exists. Do you feel that is correct?

Dr. Waterman. Yes.

Mr. Fascell. That is all I have.

Mr. McCormack. What is your answer? A nod does not go into the record.

Mr. Fascell. Dr. Waterman did say "Yes."

Dr. Waterman. I said "Yes."

Mr. Lanigan. To what extent do you think scientists' salaries are tied in too closely to the overall types of salaries in the Federal Government? Should there be a whole separate classification? What should be done to remedy the salary situation?

Dr. Waterman. It is very hard to give you a general answer because the way this affects the Government agency is by the fact that they lose their key or promising young men. It is not so much they leave in numbers as that their best men are attracted away.

To some extent this is true in the university.

Therefore, it is less a mass problem than it is a quality problem.

Mr. McCormack. That is happening before they get into the higher field of education?

Dr. Waterman. Yes.

Mr. McCormack. When they get their degrees for science or arts, business is grabbing them now. The economic outlook of every one of us plays an important point in our life. There is more than that, there is flexibility. There is regimentation.

In business they have more flexibility. In the universities there is more flexibility. There are so many other factors that are involved.

I do not think either one of you gentlemen want to say that salary itself is a dominating thought, a controlling thought, but there are other important elements that attract themselves to the mind of a scientist, particularly one who is outshining and making a great contribution, such as recognition of his services.

Furthermore, the basic scientist is a very individualistic gentleman, usually, and does not like to be regimented. I know many years ago when we had an investigation, that was a very important question, how to reorganize the military and the scientists into a scheme for the maximum benefit.

There are those natural clashes of personalities and outlook in life and so forth.

Would that enter into it, too?

Dr. Waterman. Yes, indeed. All of those do very much.

Mr. Fascell. I just wondered if Dr. Waterman and Dr. Bronk would care to comment on this problem of the scientific person finding a proper level in the community life of the United States as to whether or not science itself, the body of science, has a responsibility to achieve this level by their own public relations.

Dr Waterman. That raises a question. And I am sure that many scientists are aware of it.

Mr. McCormack. Will you define what public relations is?

Mr. Fascell. An affirmative action on the part of the body of scientists to increase their popularity, their reception, their understanding with the mass of the American public.

Mr. McCormack. I think they are pretty well respected, do you not think so?

Mr. Fascell. I am just speaking based on what I heard this morning. I have arrived at no evaluation. I have great admiration and respect for any man who dedicates his life to science. However, it has been said that this is not a general concept because of the fact that it is evidenced by economic factors such as inadequate salaries which is a mark of respect, and I might say that public officials often fall in the same class. There is a great reluctance on the part of the mass of people to pay public officials what they ought to receive.

If this is true about scientists then does this become a public relations problem? And if it does, is this something that ought to be affirmatively tackled by the body of science? In other words, Lever Bros. does not sell soap unless they advertise.

Dr. Waterman. That is a very interesting question. In the case of the individual scientist, it is a very troublesome question, too, because his motivation is not, and has never been, public relations. He is interested in his field, in his standing among his colleagues, to make a contribution to science.

Mr. FASCELL. But things have changed now. The scientist has become, as we recognize it, a focal point in national effort.

Dr. WATERMAN. What the scientists are well aware of is that they should be more articulate and more vocal in explaining science, but the notion of a campaign to sell science is something that would be very hard for them to do well, I am sure. Maybe it could be done better by others and not themselves; wouldn't you say that?

Dr. BRONK. I think that what Mr. Fascell has in mind is more than that. It starts with the very beginning of our whole educational process.

I would completely agree that the teaching of science has been inadequate. If we do not present science so that the general public can understand it, and give courses in science for those who are going to be lawyers and journalists and legislators and industrialists, then I do not think we can have an adequate appreciation of what science is disseminated all through our civilization.

There is a great deal of effort going into this. The National Science Foundation has been supporting various moves to develop programs and scientific educational methods which can be more easily comprehended by the general student body rather than by the specialist alone. At the Massachusetts Institute of Technology they have a very interesting experiment going on in developing a program of physics teaching which will upgrade the quality and make it more easily comprehended by people generally.

President Conant when he was president of Harvard used to lay great stress on understanding science, and he participated in courses at Harvard for the general student rather than for the specialist.

Mr. FASCELL. I think this is a very important point. It brings to mind a TV show called Mr. Wizard, out of Chicago, which deals in demonstrative evidence of elementary science. I think it is one of the finest things I have ever seen. I know one thing, that fellow was getting through to me. I class myself as an average American and, therefore, able to receive. And, if I am receiving, I think a lot of other people are.

Dr. WATERMAN. The universities, scientific organizations, and ourselves are interested in providing material for programs like this. And the actual performance of these things belongs in the area of those who specialize in presentation.

Mr. FASCELL. I understand that.

Mr. MCCORMACK. Are there any further questions?

All right, proceed.

ANY SUGGESTIONS REGARDING ACTIONS CONGRESS OR THE EXCUTIVE AGENCIES CAN TAKE TO FACILITATE AND STIMULATE SCIENTIFIC RESEARCH AND DEVELOPMENT IN THE UNITED STATES AND IN THE FREE WORLD, OR TO REMOVE IMPEDIMENTS THERETO

Dr. WATERMAN. My suggestions as to what the Congress and the executive agencies can do to facilitate and stimulate scientific research and development in the United States and the free world would be, in effect, a summarization of what I have attempted to say here today.

Let me say at the outset, also, that whatever the Congress and the executive agencies attempt to do along these lines can only be effec-

tive if there is an informed body of public opinion throughout the United States that recognizes the nature of the problem, its importance, and the necessity for remedial action. Our people must realize that they have a right to look to the Federal Government for leadership in attacking many of these problems, but that they, too, have a responsiblity for meeting the problem, wherever possible, at community and State levels, and in endorsing, of course, what the Federal Government plans.

As I have tried to bring out in my testimony today, Government action is needed in the following three broad categories:

(1) Education: There must be close and continuing cooperation between local, State, and Federal Government to strengthen and improve education in all fields, so that our country may have all the well-trained people needed for all aspects of national life. You will notice I say "all fields," because we need able people in all fields, especially the technical classes.

There must be a concerted effort to improve the quality of teaching in scientific and technical fields at all levels, but particularly at the secondary-school level where today many people are teaching these subjects without adequate preparation, and where the demand is very great.

There must be an organized effort to identify and motivate youngsters with special aptitudes for science and technology. Where financial support is a problem, aid should be provided.

(2) Basic research: The nature of, and the necessity for, basic research is imperfectly understood by the vast majority of people, and this has made it difficult to secure adequate funds for its proper support and encouragement. The most important single action the executive branch and the Congress can take to stimulate scientific research and development in the United States is to provide adequate support for competent research scientists, in accordance with the needs of the country in such major areas as defense and health and welfare, and above all to provide encouragement and funds to competent scientists in basic research wherever found. Only in this way can the United States make satisfactory progress in fundamental science, which is the basis for all future development.

(3) Basic research facilities: Facilities and equipment for basic research, particularly capital facilities, are urgently needed to advance the frontiers of science in many important fields of research. I mentioned these before.

The capital facilities are national needs and only a few of each are required. However, they are increasingly costly and the consequent tendency to postpone appropriations should be avoided.

In this category are included such items as high-energy nuclear accelerators, nuclear reactors, wind tunnels, testing basins, oceanographic research vessels, high-speed computers, optical and radio telescopes, large facilities for basic research in meteorology—such as aircraft and radar—and the facilities required for high-altitude research—balloons, rockets, and satellites.

Fortunately, not all fields of research require such costly items as these; but unless the country is prepared to underwrite the costs of those that are needed, its progress in science will suffer materially,

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since the areas of science they represent are among the most promising for the future.

I should like to call your attention to the fact that the Science Advisory Committee, which Dr. Killian has established, has special panels for consideration of the problems of education in the sciences and those of basic research. The former is under the chairmanship of Dr. L. A. Du Bridge, president of California Institute of Technology, the latter under Dr. E. R. Piore, who is in charge of research for International Business Machines.

At this point it may well be asked: Why do we feel justified in urging support of all competent scientific research? Will this not lead to an impossible economic situation, since obviously we do not have funds, manpower, or facilities to carry out all the promising ideas generated by the scientists? It is true, of course, that the security of a country depends not only upon its progress in science and technology but upon many other factors, chief of which is the strength of its economy.

The latter, in turn, depend upon many factors, including, of course, the proper balance among its activities and its objectives. Are we then in a dilemma?

If we make the maximum effort in research and development, do we jeopardize our economy and therefore our security?

On the other hand, if we withhold adequate support to research and development, we may help to balance the budget but jeopardize our security by failing to maintain technological supremacy.

Mr. McCORMACK. Also, a very important factor is what activities a potential enemy of ours might be carrying on.

Dr. WATERMAN. That is quite true.

Mr. McCORMACK. It seems to me that should be one of the primary questions, if not the primary question.

Dr. WATERMAN. Yes.

Mr. McCORMACK. All right; go ahead.

Dr. WATERMAN. The answer, I believe, is clear. We should encourage and support basic research to the limits of the capabilities of our scientists and engineers. By so doing, we make available to ourselves the full potentialities of all new discoveries of science.

This is not expensive—you can see from the figures I have given.

We should then give careful consideration to which of those potentialities we should emphasize and support for development and ultimate production. This is one of the best ways to control the national budget.

In this way we should be able to maintain a sound economy and at the same time achieve our highest priority goals. To support basic research fully requires relatively modest amounts of money, except for capital facilities. It is in the other stages of technology—applied research, and especially development and production—that the large costs occur. Therefore, we are not jeopardizing the national economy in providing full support for basic research. In fact, I must go further and declare emphatically that unless basic research is adequately supported, we are certain to miss opportunities for development and application that may mean all the difference between success or failure in the race before us, whether for war or peace.

Fortunately, there are modern processes of analyzing the findings of science which help in selecting those that promise the most fruitful

application. Two modern techniques, systems engineering—I call systems analysis—and operations research, can give invaluable assistance at this stage, as they are now doing; but they can be developed more fully.

Systems engineering or systems analysis is well understood by the technical industries, which have developed it to a high degree. It consists of a detailed layout of the steps required to undertake a given development—its possible directions, its bottlenecks, its time schedule, etc. A thoroughgoing analysis of this kind should determine whether a development is currently feasible or whether it should be postponed for future research, the general form and direction the development should take, possible bottlenecks, time schedule, and degree of feasibility.

Operations research consists in an analysis by special techniques of a scientific nature that were developed during the war and postwar period. Using the mathematical bases of probability and other scientific devices, operations research can predict the degree of success of a given development and especially a comparison of the effects of the new development upon operations as compared with current or older plans.

These techniques do not in themselves provide complete answers as to the wisdom of embarking on a given undertaking. However, they do provide powerful assistance to management in making its decisions by furnishing as complete data as possible concerning the feasibility, time schedule, and degree of success of the venture.

It is after we have passed the stages of basic research and selection of items for development and enter the prototype stages that the costs begin to assume truly large proportions.

Here again, technology is able to effect substantial savings. The high-speed electronic computer is able to do "research on research" in the sense that it can evaluate the performance of proposed alternative types of designs, and even of alternative weapons or weapons systems, thus obviating the need for the construction of expensive models or prototypes.

Literally thousands of variations on an airframe, for example, can be computed as to flight characteristics. Only those variations that meet specified performance characteristics need actually be developed.

A computing machine can be programed so that the characteristics resulting from an initially assumed design are calculated.

The calculated performance is then automatically compared with what is desired and the initial design modified so as to produce better agreement. This process can be rapidly repeated until a design is reached which should give a fair indication of performance to meet the specifications. The whole process is carried by the computing program in the machine without human intervention, except when a new set is required for information.

Full support of basic research, far from being incompatible with a balanced budget and a sound national economy, is absolutely essential if properly understood and wisely pursued. I like to think of basic research, ladies and gentlemen, as an investment. It is really of that character. When one makes an investment he tries to cover all of the likely possibilities as to the return that may be achieved. Some promise of a higher return but the risk is great. In others more

conservative, one is almost sure of some return but not a very large return.

In one point of basic research wisely, as I have outlined, it must go across the field because we do not dare overlook any bets. As time shows what succeeds is a general rise in income of research. That is the progress of science across the board which we are looking for, with occasional high returns. One cannot predict in advance where these are going to come, but specifically every year they do come if you have a wise investment, and that is really my conception of how it should be.

In conclusion, I wish to say that I have not overlooked the reference to the free world as well as the United States in the last topic that you asked me to discuss. To some extent the remedies with which we seek to repair and strengthen our own position in science and science education are equally applicable to all the free world.

Obviously, such objectives must be carried out with a unity of purpose and in a wholehearted spirit of cooperation that transcends national interests in the narrower sense. Most important, in my opinion, is taking steps to strengthen and extend scientific collaboration between the United States and other countries.

This includes the removal of impediments to the exchange of scientists and scientific information. As the President said the other day, "the task ahead will be hard enough without handicaps of our own making."

A recent significant step was the action of NATO in announcing the establishment of a Science Committee on which, in the words of the official communique, "all of the NATO countries will be represented by men highly qualified to speak authoritatively on scientific policy.

In addition, a scientist of outstanding qualifications will be appointed as science adviser to the Secretary General of NATO. This is indeed an important move forward, and our Government can do a great deal to insure its success by supporting the participation of the United States in the science program for NATO which the committee is expected to formulate.

Mr. McCormack. Any questions, Mr. Jones?

Mr. Jones. Doctor, would you like to enumerate some of the impediments that you have encountered in the exchange of scientific data and information with the other countries which you say are free countries or allies?

Dr. Waterman. In basic science, in the exchange of research information between the countries, I will say of the free world, that have their research magazines and publish papers, it has always been very good and still is. These are available to Government agencies. They are available to individual scientists, to libraries and many research scientists subscribe to them.

There has, of course, been difficulty with the Iron Curtain countries, and the uncertainty of getting this kind of research information over the years has been rather great.

For that reason, attempts have been made and the Science Foundation has a good start in helping to provide translations of all of the important scientific journals. You see, this is a normal medium of exchange of basic materials.

Mr. McCormack. That should be done in the United States, in our country?

Dr. WATERMAN. It is.

Mr. MCCORMACK. Is it actually being done?

Dr. WATERMAN. Yes, we have this past year seen to it that the important Russian scientific journals in physics have been translated.

Mr. MCCORMACK. What about the Soviet journals?

Dr. WATERMAN. They are available to us.

Mr. MCCORMACK. Have they been analyzed?

Dr. WATERMAN. They have not always been, but they are now.

Mr. JONES. I understand the Soviets do a much better job of taking our scientific material, cataloging and publishing it and making it available, than we do with their own.

Dr. WATERMAN. We understand that is the case, that they are very well informed on what we do.

Mr. JONES. Didn't Dr. Bush testify before the Senate committee that that was the situation?

Dr. WATERMAN. I believe so. Someone has. It is well known that they are well informed. Our scientists say that they know what we are doing.

Of course, journals are easily picked up by them and they, also read English, of course, to a far greater extent than ours read Russian.

Mr. JONES. Mr. Chairman and gentlemen, I have certainly enjoyed this session. It has been quite enlightening to me because I know so little about the subject and in grasping and understanding the problem generally it has helped, knowing what confronts you as men of science. But understanding after all, are political questions that have to be reduced to some understanding for the people of the country.

I think there is a general awakening to the great value and great accomplishments that we have made, not only for the security of the country, but for the advancement of the general welfare of the people. And I am glad to have had an opportunity to hear you.

Dr. WATERMAN. Thank you.

Mr. MCCORMACK. Any questions from you, Mr. Fascell?

Mr. FASCELL. Mr. Chairman, getting back to the point that Mr. Jones raised, on the question of making available immediately known scientific information from throughout the world, wherever it might come, it is my understanding from your testimony, Dr. Waterman, that we have received a great mass of Russian information which has not been translated and disseminated to American scientific people.

Dr. WATERMAN. We have struggled with the matter of translating it. It is not an easy thing to do, to get people who know science and the language. Recently we have been getting the Russian journals quite consistently. And the problem is make sure that they are translated and made available.

We do this. There are a number of private organizations that are doing this. And the Foundation has supported some of the work in the translation. And we have been heavily involved in it.

The National Science Foundation has an office of scientific information working on this and the Science Advisory Committee under Dr. Killian has a special panel, of which I am chairman, considering this problem.

And we have now plans between the Office of Technical Services of the Department of Commerce and ourselves to make sure that this is very thoroughly covered. And, also, what is important, too, is that

these translations of journals are available at a moderate cost, because it is an expensive job to get this work done.

Mr. McCormack. When was this plan put into operation?

Dr. Waterman. It is now going into effect.

Mr. McCormack. How long—when was it put into operation?

Dr. Waterman. The complete plan is not yet in operation, but this is underway.

Mr. Fascell. Mr. Chairman, that is exactly the point I am getting at. I would like to hear the doctor's comment. I am not sure that the statement I am making is correct, but I have heard that in Russia all publications are translated and available and disseminated within 30 days. This is worldwide, mind you. That in the United States on Russia alone we have a backlog of 10 years of information. That the translation job was almost insurmountable, much less getting it out to our scientists where it would be useful, in time.

Dr. Waterman. It is not that bad.

Mr. McCormack. How bad is it?

Dr. Waterman. We have the important work in many of the important journals translated. You see, scientists, when they look the material over, discriminate between the average run of research and the important things.

Mr. McCormack. In your paper you say:

> Let me say at the outset, also, that whatever the Congress and the executive agencies attempt to do along these lines can only be effective if there is an informed body of public opinion throughout the United States that recognizes the nature of the problem, its importance, and the necessity for remedial action.

You say that in your statement. You can help us by giving us a clear answer to Congressman Fascell's inquiry. He said "10 years." You said "not that long." Just how long?

Dr. Waterman. One cannot give a categorical answer to anything as complicated as this. The important papers get around fast.

Mr. McCormack. Is it a fact?

Dr. Waterman. The less important ones get ignored. That is why one cannot say.

Mr. McCormack. Is it a fact there has been a failure on the part of our Government and agencies to enter into this field of getting this scientific information and evaluating it and seeing that it was distributed in at least informed circles?

Dr. Waterman. It is not a complete failure, because as I was just saying——

Mr. McCormack. Is it a failure—has it been a failure? I did not say "complete."

Dr. Waterman. It has not been as successful as it should be. I am not trying to argue with you, Mr. Chairman. But we have succeeded in getting some of the important work out and available to the people. That is not as complete as it should be, and that is what the present plans will do.

Mr. McCormack. I will turn you over to Congressman Fascell.

Mr. Fascell. Isn't it true, however, before you can disseminate the important ones, you have got to translate them all? How would you be able to pick them out?

Dr. Waterman. This has to be done by the people who are actually doing the translation who know the field. They can discriminate, but

they do not have to translate each paper except to glance through it to see the results.

Mr. FASCELL. Then somebody has to evaluate the mass of information?

Dr. WATERMAN. That is correct.

Mr. FASCELL. It means that we have to have a group of evaluators?

Dr. WATERMAN. Yes; good scientists who know Russian can do this.

Mr. FASCELL. Is it not true that this is done partially by private industry in the fields where they see some immediate return and some is done by Government on some kind of a basis?

Dr. WATERMAN. Yes.

Mr. FASCELL. Isn't it true, however, that this haphazard concept will have to be changed if we are going to maintain any kind of usefulness out of the great mass of scientific data that comes from all over the world?

Dr. WATERMAN. I think it would be more helpful if more people should learn Russian.

Dr. BRONK. If in our elementary schools at a time when the young people are naturally able to learn languages, if they learned to read and speak various languages, instead of taking some of these frill courses which fill our elementary educational programs, more of our people would be able to keep in contact with the other peoples of the world, we should have less need for these elaborate translation procedures.

Mr. FASCELL. I can see that, and for a long-range program, I probably would agree with you. We will, probably, have to do this.

Dr. BRONK. The trouble is that we are not starting on that.

Mr. FASCELL. In conjunction with the long-range program it is obviously very necessary that we do something right now, isn't it?

Dr. WATERMAN. I do not want to say to this committee that this is not a very important question. It is. And we are taking steps to cover it. Let me add though——

Mr. MCCORMACK. Whose fault is that primarily, Dr. Bronk?

Dr. BRONK. Well, I think that our State departments of education could do a lot to clean house.

Mr. MCCORMACK. Well, what about the institutions themselves? Where should we start?

Dr. BRONK. Being president of a graduate university I cannot start very well. I have to try to put up with the poor product we get. I wish you could advise me how I could reach down into the elementary schools and help.

I have a university sophomore son who is still suffering from the fact that he went to a progressive school where he didn't learn to read until he was 9 years of age.

Dr. WATERMAN. This is true about the way the scientist works, that he will get, by hook or by crook, what he needs in his work if he possibly can. They are very good at it. For example, you take an average scientist who is working in the field of physiology, we will say, he needs to know what is going on in the world, but he has to make an original contribution, if he can.

Mr. FASCELL. I understand that.

Dr. WATERMAN. What he will do——

Mr. FASCELL. He will spend 9 years running down some matters so he can come up with the answers. Instead, if we had a system that would provide him with the material he could do it easier.

Dr. WATERMAN. He will not wait 9 years. What he does——

Mr. FASCELL. What I am getting at is, that under the present system, that basic fundamental searching for ideas upon which to build, is built into the scientist's work?

Dr. WATERMAN. Yes, it is.

Mr. FASCELL. This is where he must spend his time?

Dr. WATERMAN. Yes.

Mr. FASCELL. Not only the ultimate. If he could spend all of his time on an evaluation of the materials which are before him without the necessity of using his time to go get the material, we would be that much better off, would we not?

Dr. WATERMAN. Yes. I am not arguing it is not an important subject. It is very important that we should do something.

Mr. FASCELL. I want to get it in the proper reference to get to the next question.

Dr. WATERMAN. I wanted to make this clear that an individual scientist knows how to get these things himself.

Mr. FASCELL. I do not doubt that.

Dr. WATERMAN. For example, this physiologist I spoke about——

Mr. FASCELL. The only question I raise is whether it is efficient.

Dr. WATERMAN. If he suspects that things are happening in Russia that he wants to know about he will find a friend of his who knows Russian and that friend will tell him, "You had better watch out for this," and soon in that way he gets into it. Whether he can do it——

Mr. FASCELL. I would take off my hat if I had one, to the ingenuity of the scientist, but it gets back——

Dr. WATERMAN. This is not enough.

Mr. FASCELL. It gets back to the problem—and I wanted to ask you whether or not in your concluding remarks you are dealing with the problem of basic research strictly from a governmental standpoint?

Dr. WATERMAN. I am trying to deal with it so as to give you the view of the scientist's needs.

Mr. FASCELL. I understand in discussing this, in your concluding remarks, you have reference to what government should do.

Dr. WATERMAN. That is right.

Mr. FASCELL. In basic research and eliminating all private industry and individuals?

Dr. WATERMAN. And we do have a plan for it, and this is very important to go ahead with it. But we have already made progress; I cannot say we have not.

Mr. MCCORMACK. When is this plan going to be put into operation?

Dr. WATERMAN. Starting almost right away.

Mr. MCCORMACK. On the evaluation, you mean?

Dr. WATERMAN. We are providing funds to the Department of Commerce to proceed with a general analysis on provision of abstracts on scientific papers.

Mr. MCCORMACK. I know, it is in the discussion stage, but not in the actual decision stage.

Dr. WATERMAN. It has been decided; yes.

Mr. McCormack. But not put into operation yet—about to be?

Dr. Waterman. It is about to be; that is right.

Mr. McCormack. This is no criticism of you, personally, but I was amazed when I read in the paper that it was not being done. I assumed that some agency of our Government was doing that because they ought to do it. I was simply amazed.

Dr. Waterman. There already has been work done. For the past few years that we have supported providing full translations of important papers in physics and with the cooperation of the scientific societies. That has, also, been done with mathematics and the biologists are, also, active in this. So the only trouble with the present plan is that it is fragmentary and not complete. We want to get it up to where it is complete.

Mr. Fascell. That is a very interesting thing, because I think it gets to the root of an efficient method of operation to give scientists, the individuals, the tools with which to work. As I understand it this is a very important tool. Will this be complete within government—will it be available outside of government?

Dr. Waterman. Yes, outside.

Mr. Fascell. And it will be a total abstracting?

Dr. Waterman. On the important features of science. The abstracting of the papers to show what is in them and then the complete translation of the important ones. That is the general plan.

Mr. Fascell. It will be total in concept?

Dr. Waterman. Yes.

Mr. Fascell. And you are shooting for immediate availability, of course?

Dr. Waterman. That is right.

Mr. Fascell. And this will take you a period of some time and basing my opinion on the time required to set up an abstracting plant for land titles, I would say several years before you would have a workable and efficient scientific abstracting organization started.

Dr. Waterman. In the matter of the use of these things ultimately, of course, we get back to the knowledge of the Russian language. That will be the simplest and most efficient. As scientists have done in German. If they had a knowledge of Russian that would eliminate a lot of this trouble.

Mr. Fascell. What conflicts will there be, if any, or what coordination will there be, if any, between this concept which you have stated here and the operation of private abstract companies?

Dr. Waterman. They would all be in the picture. It is one thing to survey what is being done, and another to make sure that everyone knows where he can go for a particular abstract or translation of particular things.

Mr. Fascell. Do I understand then that this thing envisions the availability of current abstracts by private industry as in the field of biology?

Dr. Waterman. All of these fields will be included; that is right.

Mr. Fascell. Is that simply a matter of photostating what is available and then transferring it over to some central unity like this Department of Commerce operation or will this continue to operate separately and apart based on some kind of charge to the scientist, or to the Government agency, that has the information?

Dr. WATERMAN. As to the dissemination of information, the scientist goes where he can get it best.

Mr. FASCELL. Whether you have to pay for it or not is not part of the contract?

Dr. WATERMAN. The idea is to work on it until the individual scientist can get the reports at a moderate cost.

Mr. FASCELL. Let me see if I can follow this through. A group of scientists in the Department of Defense are working on a problem which has indirect bearing in a biological field. And at the present time they can go to a private abstract company and pay on a contract basis for whatever they need. I do not know how current it is, but it is there?

Dr. WATERMAN. Yes; that is the general idea that we are aiming for.

Mr. FASCELL. And then they would, also, be able to go to this new organization set up in the Department of Commerce, which is a governmental agency, for areas which are not covered by private industry?

Dr. WATERMAN. On the abstracting.

Mr. FASCELL. On the abstracting only. And this information would be made available, of course, across the board to the Government?

Dr. WATERMAN. Yes.

Mr. FASCELL. The question I am asking is whether or not it would be made available to private industry?

Dr. WATERMAN. Oh, yes.

Mr. FASCELL. And this again would be without charge—this is a public service?

Dr. WATERMAN. A public service—that would be right, but not necessarily without charge.

Mr. FASCELL. There is no conflict, therefore, that arises?

Dr. WATERMAN. On the information that can be provided.

Mr. FASCELL. What I am getting at is as to the organization of these private companies, you say there would be no difficulty there. That is what I am getting. This is a clear field for a Government need.

Dr. WATERMAN. Right.

Mr. FASCELL. It is noncompetitive with private industry?

Dr. WATERMAN. Yes. Everyone will be informed where these sources are. Until the plan is worked out one cannot say what the charges will be. It will be available to everyone.

Mr. FASCELL. I follow you. That clarifies the point.

Mr. MCCORMACK. Is there much difficulty in getting publications in the field of science and so forth from the Soviet Union?

Dr. WATERMAN. I believe there is very little difficulty now. There has been in the past. That has come and gone.

At this point I should like to put in the record the following résumé relating to Federal Government generated reports in science and technology and scientific and technological information from foreign countries:

I. FEDERAL GOVERNMENT GENERATED REPORTS IN SCIENCE AND TECHNOLOGY

The Office of Technical Services in close cooperation with the Armed Services Technical Information Agency and the National Science Foundation acquires unclassified Government reports in science and technology and issues a monthly

bulletin of titles available. This bulletin includes a brief annotation regarding the contents of each report. The National Science Foundation, in order to improve this service and to make sure that Government generated report literature in the field of pure science would be available, made grants to the Office of Technical Services in 1957 and 1958. With increased personnel supported by these grants the Office of Technical Services has been able to increase the listing of reports prepared by the Federal Government by 30 percent in 1 year. Out-of print reports for which a small demand is anticipated are deposited by Office of Technical Services in the Library of Congress where scientists can get a photocopy at a nominal cost. In addition, the NSF had made grants to the Library of Congress in 1957 and 1958 to collect and organize a complete file of significant Government generated reports in science and technology. The Library is organizing this file and making the reports available through its normal channels of reader service, photoduplication, and so forth.

Within the NSF a clearinghouse has been established where a scientist can write, telephone, or visit to obtain information on current unclassified research supported with Government funds and also be given information on report literature pertaining to his interests.

Recently the Department of Defense has approved the NSF's checking catalogs of classified documents for the purpose of identifying significant research reports in science and technology that should be considered for declassification. Although not all unclassified Government reports are available to OTS at the present time, the receipts are increasing, and with the assistance of the present and future NSF grants and the present cooperation among the Government agencies there should be available to the American scientists total information on unclassified research and copies of reports pertaining thereto.

II. SCIENTIFIC AND TECHNOLOGICAL INFORMATION FROM FOREIGN COUNTRIES

A major portion of the world scientific literature is now received by the Library of Congress, the National Library of Medicine, and the library of the Department of Agriculture. In addition, such other Federal Government libraries as AEC, Interior, and NBS acquire foreign scientific information necessary for these agencies. In addition, the NSF has made grants to the Midwest Inter-Library Center for the purpose of acquiring all foreign scientific journals in chemistry and biology. This program will be expended in other fields of science.

Within the past 2 months a cooperative plan has been endorsed by the Federal agencies interested in Soviet scientific and technical information which envisions the OTS in the Department of Commerce establishing a clearinghouse on all translations going on within the Federal Government as well as elsewhere in the United States; developing a plan for disseminating translated material prepared by the Government either through OTS publication or by release to publication mediums established by professional societies or commercial organizations. In addition, the NSF and the OTS in cooperation with scientific professional societies, private organizations, and agencies of the Federal Government, will identify additional areas where more translations need to be done. Additional funds for fiscal years 1958 and 1959 have been requested by the NSF for the purpose of increasing the total translation effort in this country. In addition the Commerce Department is making plans, if Congress approves, to transfer funds from other appropriations to OTS in 1958 so that it can initiate its part of the program mentioned above.

At the present time, the National Science Foundation through grants is supporting complete translations of 16 scientific journals: 4 in biology, 3 in electronics, 2 in geophysics, 1 in mathematics and mechanics, 2 in metallurgy, and 4 in physics. The National Institutes of Health is supporting the translations of eight journals in the medical field. The Atomic Energy Commission, the National Science Foundation, and the National Institutes of Health all are supporting either directly or through grants translations of abstracts of other Soviet scientific material, and these are being published through normal scientific publication mediums. Plans are now underway to expand this translation program until the more important Soviet scientific journals are completely translated, and all journals with significant scientific and technological information are abstracted.

The NSF also is calling together the heads of all mechanical translating projects in this country to explore ways in which better cooperation and more coordination can be achieved in order that the use of mechanical means for translation can be developed more rapidly. The NSF is supporting a conference

of 14 major abstracting services of this country at the end of January which will study the problem of increasing coverage of foreign science and explore ways for improvement of these services. Several meetings are planned to explore ways to effect coordination and to speed up research on use of machine techniques in the storage and retrieval of scientific and technological material. These meetings are being organized by the National Science Foundation.

It is expected that through the medium of these and other meetings, areas will be identified for intensifying work and methods for reaching solutions to problems will be determined.

Mr. McCormack. Any questions, Mr. Jones?

Mr. Jones. No further questions.

Dr. Bronk. Mr. Chairman, with regard to this matter of disseminating information, I think it is important to bear in mind that one of the most effective ways of exchanging information, especially in view of the fact there has been such a tremendous accumulation of scientific knowledge, is through conferences and personal associations. One of the problems we have been continually confronted with is the difficulty of getting adequate funds to make it possible for scientists and technical people, generally, to travel from one place in this country to another for conferences and scientific meetings and exchange of information, in this country and other countries. It is better than it was. But there is still a very great need for doing something more effectively in this field.

It is the same problem you gentlemen faced when they clamped down on your free travel around the world so that you could become familiar with world problems and deal with those matters legislatively. We have had great difficulty in getting travel money for scientists to go and get the information which would save a great deal of time and money and not repeat what has already been done.

Mr. Poland. With respect to this question of availability, I note here you say, "There are modern processes of analyzing the findings of science," and you mentioned systems engineering and operation research and computers. Will you comment on the availability and the utility of such systems in terms of making uniformly and quickly available the material we are talking about with some notion as to its selectivity and immediate utility in the scientific world?

Dr. Waterman. I will have to explain it a little further, Mr. Poland. What I am talking about there is when one is trying to make a selection between the different developments that should be pursued——

Mr. Poland. I understood your statement applied to that. I was trying to make another application of it.

Dr. Waterman. In science itself——

Mr. Poland. In the availability of information, the application of these techniques to make the information available.

Dr. Waterman. I understand. In the availability of these things for the dissemination of the information, the same technique can be used to the extent that it may be needed. Well, this is a greater problem here than just the straight dissemination. When one takes in the scientific work which is going on, and wants to make it available, regardless of language now, what one is faced with, first, is a classification of the field.

Mr. Poland. The material within the field?

Dr. Waterman. Within the field, or whether you are going to classify it, say, by a particular branch of mathematics or by computer or some application. This is a perplexing problem that the librarians

are faced with. Once you have classified it and stored it, you have to find it. That is where these techniques can be extremely helpful. And this is one of the problems that we are attacking at the Foundation and in many agencies. We want to be able to find out what is the best way of recording the information, classifying, storing, and then finding it quickly and reproducing it when desired. That is one place where these modern techniques can be most helpful, and it has not been solved at all.

Mr. FASCELL. At this point, may I inquire?

Mr. MCCORMACK. Yes.

Mr. FASCELL. Do you have knowledge as to whether or not the Russians have actually mechanized the whole process you are talking about, so that they can press a button and get this knowledge out of storage?

Dr. WATERMAN. I have not; no.

Mr. FASCELL. Do you feel there is a possibility that they have progressed that far in the cataloging and storage and processing of scientific data?

Dr. WATERMAN. I have no doubt they are trying to do it, but I would doubt they have the knowledge to do it well.

Mr. FASCELL. As I understand it, you are saying that the Russians have established a national scientific clearinghouse, but they haven't used the latest electronic equipment throughout the system.

Dr. WATERMAN. I just don't know, but I doubt whether they have done it to any very substantial degree. Incidentally, I don't think this is the right way for us to do it, to establish one single clearinghouse, because the needs of scientists are very specific, and it is quite a personal thing. The scientist would much rather work with an agency doing these particular things in his own field than he would go to a central place where he is given no individual attention and where the system is entirely mechanized. I suspect the Russians are finding this out.

Mr. FASCELL. This gets to the difference between our type of government and any totalitarian government. And it deals with everything we have to do, whether we have to follow their way of doing things to get anything done. If we once admit that——

Mr. MCCORMACK. Doctor, in relation to an informed body of public opinion throughout the United States that you referred to, isn't an important part of that—that goes back to the democratic institutions of government—the people being informed so that they can arrive at an opinion in an important matter; then, through public opinion, they have a sound and rational public opinion, as distinguished from an emotional one, which, usually, by way of action, is erroneous. I have found that in my experience under trying moments.

Dr. WATERMAN. Yes.

Mr. MCCORMACK. Doesn't that also involve that the Government advise the people, let the people frankly know all information in all fields that at a particular time is not inconsistent with the national interests of our country?

Dr. WATERMAN. That is the way we do it in this country; yes.

Mr. MCCORMACK. Well, do you think it is being done?

Dr. WATERMAN. It is a hard thing to do completely.

Mr. MCCORMACK. I didn't say completely.

Dr. WATERMAN. It is being done; yes.

Mr. McCormack. Does the National Science Foundation do it?

Dr. Waterman. We try to do the best we can, within our means.

Mr. Fascell. I think it would be very important to get clear in the record a proper reference. As I understood it, the doctor made a qualifying statement that, I think, went unnoticed. I think he said "within his field."

Dr. Waterman. Within our means.

Mr. Fascell. Well, now, what area of information are you talking about? The chairman, I believe, had in mind total Government information of the United States. Did you have the same idea?

Dr. Waterman. To some extent, because we have responsibilities in that direction. For example, we can give you a list of our publications, which cover more than just the programs of the National Science Foundation.

Mr. Fascell. But he had in mind policy matters, you see.

Dr. Waterman. Well, policy matters——

Mr. Fascell. Of national import, as they affect our organization. You can testify as to the availability of information as it might have a bearing on these things?

Dr. Waterman. These are made in public addresses; they are made in our writings; they are made as we take steps along lines of establishing policy. Oh, yes.

Mr. Fascell. I just wanted to be clear that in response to the chairman's question, you were limiting your answer to your own field.

Dr. Waterman. For example, we have made studies of research and development throughout the country, scientific manpower, training facilities, what the Government is doing. We have a report each year on Federal funds for science, the part of Federal funds spent for science.

Mr. McCormack. I didn't have that in mind. Anybody can dig that out of the budget, if we want to do that. Most of it, I mean.

In order for there to be an informed public opinion, the people have got to have the facts.

That is correct, isn't it?

Dr. Waterman. Yes, sir.

Mr. McCormack. Do you want to leave the record rest, that you think they are being given all the facts that can be given to them?

Dr. Waterman. That is a rather sweeping statement. I think there is an effort to try to give people facts. In this particular field, we are anxious that people should know the facts in science, so that they will get behind the support of science in basic research and training. We have done everything we can to try to succeed in that.

Mr. Jones. Do you mean to say you are not trying to obscure any of the facts?

Dr. Waterman. That is certainly true.

Mr. Jones. Thank you.

Mr. McCormack. Well, now, in your position, you know that you are not confined to the strict operation of the National Science Foundation in your knowledge of what other agencies are doing.

That is true, isn't it?

Dr. Waterman. Yes; I am involved in basic science in all of the Government agencies, and belong to various committees of one sort or another in connection with other agencies, apart from the work of the Foundation itself.

Mr. McCormack. That is going to be looked into by another committee in the future, so I won't go into it.

Mr. Lanigan. May I ask some questions?

Mr. McCormack. Mr. Lanigan.

Mr. Lanigan. I have two major questions:

First, I just wonder whether you have given full consideration to some of the organizational difficulties that might be said to beset basic research activities. I have in mind the Weather Bureau and your reference to the need for weather flying laboratories.

Now, as you know, the Weather Bureau is within the Department of Commerce, which, on the whole, is not a scientific agency.

I just pick one year here, for example.

We have some material from the Commerce Department on how the Weather Bureau budget requests were handled. I noticed that in 1956, they asked for $1,500,000 for basic research—that is, the Weather Bureau asked the Commerce Department. But the Commerce Department asked the Bureau of the Budget for only $168,000. The Bureau of the Budget asked the Congress for $168,000.

I think, in this case, the Congress has had a tendency to raise their appropriations a little over what they have asked. But the point is, this major difference was this weather plane.

If we go back to history and follow through right to today, we find that this weather plane never gets past the Weather Bureau, or past the Commerce Department. So it seems that where you have a basic research organization, or an organization which does certain basic research, as a component part of a large department, there is a definite danger that the bureau's thinking of its needs—I think everyone concedes that a flying laboratory is most essential—never gets even to the Bureau of the Budget, let alone to Congress. There is no knowledge in Congress of that need and request for the money.

I suspect this may be true in other agencies which are in other departments. I don't have an analysis at my finger tips on other agencies. But I wonder if you have found that this is a problem, this putting of basic research agencies within larger agencies which do not have basic research as a major interest?

Dr. Waterman. This is a fairly general situation, of course. Most laboratories—most research laboratories and agencies go into more than just basic research. In the Government, I think this is always true. The Weather Bureau, for example, has an operating program throughout the country to manage, and they have to develop instruments and train people to carry that out.

The Weather Bureau is itself an agency with a mission. Associated with this is basic research. So that is only a part of their program.

Now, it is quite true—you gave an illustration that does come up many times. This is always unfortunate, of course, because in fundamental research and in the service of mission, an agency does need things which sometimes are costly, which it has to have to get the data the best possible way.

This always runs into budget difficulties, because there are so many of these requests and one has to do what one can.

These things have to be handled when they arise, and often are handled in other ways.

For example, on certain projects in meteorology, the Department of Defense has cooperated by furnishing military planes. So there must be projects, then, which, for that purpose, can use military planes.

Mr. LANIGAN. I understand the military planes do not have the complete instrumentation which is needed for a flying meteorological laboratory. You mentioned the need right in your statement, so I assume it exists, but it has never been called to the Congress' attention in the form of an appropriation request.

There is something wrong in a situation where such a basic facility is needed, but it can't even get out of the Department.

Mr. JONES. I will say this for Dr. Waterman: I am quite sure that his experience with the Bureau of the Budget would be like every other agency and activity of the Federal Government in its communication and discussion with the Bureau of the Budget, which leads me to this question:

Dr. Waterman, in your transmission of requests to the Bureau of the Budget, have you had discussion with any of the representatives of the Bureau of the Budget with respect to the appropriation or the items for appropriations submitted to them?

Dr. WATERMAN. You mean, ours, or others?

Mr. JONES. Yes, sir; yours.

Dr. WATERMAN. Oh, yes. We always do.

Mr. JONES. With whom do you talk down there? Do you talk to a scientist, to an engineer?

Dr. WATERMAN. They do not have scientific specialists in the Bureau of the Budget, but——

Mr. JONES. How are they able to determine the relative merit of the various items composing your request, your budget request?

Dr. WATERMAN. Only in the way that people who are experienced in analyzing budgets can make up their minds from what is said.

Mr. JONES. But they must have some basic understanding of the items and the activities that are going to be embraced in that capacity.

Now, you have spoken of impediments. Can you think of a greater impediments than going down to ask for money to carry out research and have it presented to someone who knows absolutely nothing about the proposition you have raised, except how much money we have got and how much is going to be apportioned to Tom, Dick, and Harry, along the line?

Dr. WATERMAN. Well, things aren't as extreme as that. The Bureau of the Budget people are quite able, and in the assignment of individuals within the Budget who deal with the agencies, over the years they acquire a pretty good background. That wouldn't be as much as the scientists have, but they have a point of view which is valuable.

Mr. JONES. I appreciate their great concern for the keeping of the fiscal affairs of our Government but, at the same time, here they are determining policy, and they are ill-equipped to make those judgments and those determinations; don't you think?

Dr. WATERMAN. I would think here—I could make a general remark that with the importance of science and technology, one would find it advantageous in each agency to have someone such as an assistant secretary, who has a good knowledge of research and de-

velopment—including the Bureau of the Budget—someone at the top level. It doesn't need a complete staff, but someone who is versed in this.

If you try to take the alternative of setting up a scientific staff to pass on the needs of an agency, that can cause a great deal of frustration, because the operating agency knows these things very thoroughly, more thoroughly than the planning group can, so that there is a danger of a less competent group overruling the group that really needs these things. I think they could be handled by one——

Mr. FASCELL. It is just a question of who is going to overrule you, an incompetent scientific group or somebody else.

Dr. WATERMAN. As you know very well, every agency has its own needs, and it is apt to ask for more than it can get because there has to be a limit.

Mr. JONES. Don't you think it is an unusual arrangement to have the board of directors of a corporation establishing the policy and the course it will pursue, but it gets down to the fiscal officer, and he says: "Well, you can't do that," even though he knows nothing about the proposition you are up against? But yet you are having him to determine the policy, and you have got to forego your ambitions or your endeavor because the fiscal officer over there, who is not acquainted with the facts and who is not brought into that, ultimately is going to do the very same thing that Dr. Bronk pleaded with us yesterday for; on continuity of this program.

How do you have continuity if you don't have someone there to determine not only the fiscal policy but the general overall policy of continuing scientific research? If he has to reconcile it to the overall amount of money available for a given period, how is he going to succeed because it is an irrelevant position and it has to go up and down according to the whims of Congress and that sort of thing. Who are going to dictate the policy with regard to the debt ceiling, the requests, and all the other items?

Dr. WATERMAN. The only way I can answer that is that with any large question, such as the program of an agency, this necessarily involves a number of factors.

One is the special experience and competence of the agency in dealing with its own field and what it needs.

Another, of course, is whether the country can afford it. That brings the financial aspect in.

Still a third is whether this conforms to the policy of the country as determined by the executive branch and the legislative branch, a balance has to exist between components of the Government's program.

Mr. FASCELL. A question of priorities.

Dr. WATERMAN. And the question of priorities.

It is not true, to my way of thinking, that a fiscal agent makes the final decision. All these other matters will get in.

If there is any question about a fiscal point of view not being correct, then other elements are brought into the picture. The policymakers—Congress has to make the final decision, and the executive branch enters importantly.

Mr. JONES. I am glad you brought that point up, because I know of agencies that have been requested to supply the congressional committees with information of the request that went to the agency, and

before it could set up or transmit its opinion on the subject sought, it had to be cleared with the Bureau of the Budget, and that letter has been standing in the files of the Bureau of the Budget for over 2 years.

Now, I wonder how we are going to get communications from the executive branch of the Government, Dr. Waterman, and what you think about various propositions, if you have to be cleared and have to have your security acknowledged by the Bureau of the Budget to give out your ideas of the relative importance of the proposition that you are assigned?

Dr. WATERMAN. I must say I am not a specialist in relations of this kind. I can hardly give you a very definite answer on this.

Mr. JONES. I am quite sure if we talk about the Bureau of the Budget, we will be here a long, long time.

Dr. WATERMAN. Except that it makes sense to me to have a consistent position established by the executive branch. Otherwise, we can make no progress.

It seems to me their position, as stated to the Congress, has to be a consistent one, otherwise one would have chaos.

Mr. FASCELL. Would the chairman yield at this point?

Mr. JONES. Yes; I am through.

Mr. FASCELL. Am I correct, Dr. Waterman, that the correct interpretation of your position is, however, that today there ought to be greater emphasis on basic research, financially and otherwise, by the executive and legislative branches?

Dr. WATERMAN. I agree.

Mr. FASCELL. But it has to come from the Executive first?

Dr. WATERMAN. I would think so.

Mr. LANIGAN. I want to pursue this weather plane a little farther——

Mr. POLAND. Would you excuse me just a minute, while we pick up the final statement with respect to the budget request?

Dr. Waterman emphasized consistency, and the Foundation has been courteous in furnishing us with some figures which I have before me, as to what the Foundation estimated its needs to be in various fiscal years, and what the President's budget included.

Without going down through the full details, they started the first full year with fiscal 1952, and they asked for $14,780,000, and got $14 million. That is—I am speaking now of the President's budget.

The next year, they asked for $15 million and got $15 million.

In 1954, they asked for $15 million, and got $15 million.

The next year, they asked for $20,600,000, and got $14 million.

The next year, it was $24,650,000, and they got $20 million, which was reasonably consistent.

Then, in 1957, they asked for $58 million and got $41 million.

In 1958, they asked for $104 million and got $65 million. Subject, I understand, to possible correction; the present request is for $341 million, and the President's budget included $140 million.

It seems to me, on the basis of the consistency in the application of fiscal practices, that leaves something to be desired.

Would you want to comment on that, Dr. Waterman?

Dr. WATERMAN. As far as I can see that figure of about $340 million would represent all the programs we were considering in the Foundation. We never required a budget for all these programs or in this

amount. The full facts are on November 5, 1957, the National Science Foundation submitted to the Bureau of the Budget a request for fiscal year 1959 of $147,733,260. Shortly thereafter, in response to general reconsideration of the scientific effort within the administration, the National Science Foundation listed programs in education in the sciences totaling $240 million, instead of $51 million contained in the $147,733,260 request. This would have brought the total programs to about $340 million. However, after further discussions within the administration, particularly with the Department of Health, Education, and Welfare, it was mutually agreed that some of the most costly of the Foundation's educational suggestions could best be administered by the Office of Education, that a program which the Foundation felt to be of doubtful appropriateness for the Federal Government at this time should be omitted, and, finally, the Bureau of the Budget did not approve of seeking funds for the Institutes' programs for 3 years as suggested. After allowing for all these deletions we believe that the final request of the National Science Foundation for purposes of comparison should be considered as approximately $222 million, although no such figure was ever formulated as such and submitted to the Bureau of the Budget.

I would say, without being a fiscal specialist, that this is a very normal thing. After all, there is a limit to what the country can plan and what it can afford. Any agency is likely to ask for more than can be accommodated.

Mr. JONES. Did you do that?

Dr. WATERMAN. What?

Mr. JONES. Have you asked for more than you could use?

Dr. WATERMAN. No, not at all. But somebody has to call a halt. Each agency can't ask for and get everything it wants. There must be some control over that.

This matter of consistency I speak of in what the Government decides is, it seems to me, very important, because every agency cannot know the relative needs of the others, and it cannot know general policy. So it cannot speak to its own budget authoritatively in all particulars—what the country can do, how it will be paid for, and all that.

Mr. JONES. Do you think it is a healthy situation for this country: That your fine knowledge and experience as the head of that organization that can contribute so much to this country is used to determine these facts for somebody down there, that we call one of these pencil pushers, to find out that it is not consistent with the overall budget, so he reduces it? Don't you think we ought to have somebody down there that is better equipped to make those decisions then the quality of the decisions we are getting out of the Bureau of the Budget?

Dr. WATERMAN. These decisions, when they depart from ours, are not settled by the lower level of people on the staff at all. They are discussed with the heads there, and also outside the Bureau of the Budget, so one mustn't suppose that this is entirely due to some lower employee in the Bureau of the Budget.

It is the people who are at the working level who get to understand one's program very fully, and they do. That is really a help to us.

Mr. POLAND. I understood in your reply to my question, Dr. Waterman, it was to the effect that there were overriding conditions like the ability to pay and the amount of money available, and I sympa-

thize with the position you find yourself in, but it seems to me that that constitutes an admission that the decisions are not made on the basis of the need for basic research, but rather on the fiscal considerations which are presented to the Bureau of the Budget.

Dr. WATERMAN. In the sense that we have a chance to talk about what we need in basic research, we do have a chance to state our piece. The programs that we have or that we want get a full hearing. That factor is in the situation as well.

But what I am pointing out is there are other factors necessarily involved.

It is just like the case where a given firm, say, has limited funds they can invest in work they can do. Then they find out from the departments how much they need, and the same process has to be gone through.

There has to be not only the relative needs of the department in its technical area, there has to be some control over the fiscal side, and some from the policy side. Those three things always have to enter in.

Mr. POLAND. Mr. Hoff brings to my attention the fact that I stated the question in terms of basic research, as though that were basic research only. The record ought to show that includes the entire budget request.

Dr. WATERMAN. Yes.

The last item you mentioned here in 1959, Mr. Poland. The reason for that large reduction was because the Office of Education, by final arrangement, was able to take a large part of that program. That makes that outstanding difference there.

Mr. POLAND. It didn't take $200 million worth.

Dr. WATERMAN. Then another thing that happened was, whereas we wanted to carry on some of our programs for a continuing period of 3 years, this was reduced to 1 year support at a time—in other words, the Bureau of the Budget reduced our request by approximately $80 million.

Mr. LANIGAN. On this Weather Bureau plane item now, if the basic research in weather were put under the National Science Foundation, as I believe the President's Advisory Committee on Weather Control has suggested——

Dr. WATERMAN. That is just the cloud physics part, not the whole of meteorology.

Mr. LANIGAN. If this whole function, not just the basic research, which involves this plane, were put into the Science Foundation, then there would be some agency to come to Congress and call to the country's attention the need for this type of facilities, whereas in the Weather Bureau it doesn't even get out of the Commerce Department.

As I understand it, the Bureau employees normally are not permitted to ask for more than is approved at the departmental and Bureau of Budget level when they come up to Congress. They are bound by the President's budget. So the Congress doesn't know, and the country doesn't know, about this until we happen to have a situation like this, where you come and tell us, and Dr. Berkner writes articles which appear in the Atlantic and other places, and call attention to this need.

Isn't there some organizational change that could be suggested to make these needs better known to the country, and to provide a spokesman who will forcibly bring these needs to everyone's attention?

Dr. BRONK. May I answer that, Mr. Lanigan?

Mr. LANIGAN. Yes.

Dr. BRONK. I have appeared, I think, before every congressional hearing on the National Science Foundation budget. If you go down through these figures which we have here, you see that the budget submitted in 1952 is $14 million. I argued strongly for it. We got from Congress $3,500,000.

What more can I do? If Congress is more interested in listening to the Russians than it is in listening to me, what am I going to do?

Mr. JONES. That is right.

Dr. BRONK. I can go on to the next year. The budget was submitted at $15 million. We got $4,750,000—about a third. Again, they were not interested in listening. They are now listening to the Russian achievements more than they were to the Americans who have given a lifetime of devotion to the national interest. How much louder should we talk?

Mr. JONES. About the only thing we can really justify and talk about is that the justification for doing something is because the Russians have done it. Otherwise, we can't talk about it, because, after all, the Russians don't have it, so why should we worry about it?

So we are restricted to doing only those things that Russians have been able to accomplish. That is the reason, in my opinion, that we are going to be a second-rater in some fields of scientific endeavor if we don't take the bridle off our scientists and give them greater encouragement to proceed.

Mr. POLAND. May we offer these figures which I just read for purposes of the record?

Mr. JONES. I think the reporter took them down.

Mr. POLAND. I didn't read them clear across the board. The last column reads what was actually appropriated, which I didn't read.

Mr. JONES. Without objection, that list will be made a part of the record.

(The list above referred to, in its entirety, is as follows:)

Fiscal year	National Science Foundation requests	President's budget	Appropriated
1951	[1]	$475,000	$225,000
1952	$14,780,000	14,000,000	3,500,000
1953	15,000,000	15,000,000	4,750,000
1954	15,000,000	15,000,000	8,000,000
1955	20,500,000	[2] 14,000,000	12,250,000
1956	24,650,000	20,000,000	16,000,000
1957	58,791,000	41,300,000	40,000,000
1958	104,228,000	65,000,000	40,000,000
1959	[3] 222,000,000	140,000,000	

[1] No regular request—in supplemental.
[2] Limitation of $15,000,000 removed by amendment of the basic National Science Foundation Act.
[3] During the consideration of the 1959 budget request, the National Science Foundation listed, but did not submit to the Bureau of the Budget, projects totaling $340,000,000 for possible inclusion in the budget. This was subsequently revised so that the projects for which funds were actually requested amounted to about $222,000,000.

Dr. WATERMAN. May I go back to this question of Mr. Lanigan's?

There are ways of getting at this, namely, the calling in of military services for plans to complete the jobs.

Also, there is this other matter on some of our grants in the fields of meteorology, where, under contract or a grant, a plane can be employed and fitted up for the purpose.

Your point still remains that it would be good for the Weather Bureau to have a flying laboratory. As these fields get surveyed, and in the Foundation this is one of the things we do, we can point out the general need in the field of research and meteorology and bring it to your attention, as we do now. It might also be worthwhile to consider having an Assistant Secretary for Research and Development in each department having a strong scientific program.

Mr. LANIGAN. There is one other thing, and that is the effect of rising costs. What have the costs of research been? How have rising costs affected the amount of research that can be accomplished with the dollars that you have?

Dr. WATERMAN. That has been an important factor, of course.

To some extent, the salaries of people have gone up, and the costs of equipment have gone up. That means, of course, these increases that basic research has received are, to some extent, paper increases, to the extent that what you say has happened—only paper increases.

Mr. LANIGAN. Have you made an analysis——

Mr. JONES. We are going to have to carry this over until tomorrow, unless you want to defer those questions to Dr. Bronk.

The chairman had to leave and Mr. Fascell had to go to the airport to meet his family coming on, and I think this inquiry is quite important. Certainly it should fall on the good ears of the members of this committee.

I wonder if those questions that you have could not be asked of Dr. Bronk tomorrow?

Dr. BRONK. I am afraid I have got to meet a budget in New York tomorrow.

Mr. JONES. Well, I will tell you, meeting a budget and a note due at the bank and the paying of your insurance policy on time are about three of the most important things. So I can undersand why you can't be here.

Mr. LANIGAN. I think we are just about through.

Mr. JONES. I am sorry. I understood you were going to be back tomorrow.

Mr. POLAND. No; there is another witness tomorrow.

Mr. JONES. I am sorry.

Let's proceed, then. Then you will be relieved of coming back.

Mr. POLAND. Might I ask through you, Mr. Chairman, whether Dr. Bronk, who didn't submit a prepared statement, had any additional advice he would like to give us?

Dr. BRONK. You gentlemen have been so courteous in letting me speak whenever I had a concern, in the old Quaker sense of the word, that I don't think I have anything particular to add, but I will be glad to answer any questions.

Mr. JONES. All right, Mr. Lanigan.

Mr. LANIGAN. I don't have any more specific questions. I think the rising costs, if you are pressed for time, Mr. Chairman, have been covered in some correspondence, which can be put into the record at a later date, with the National Science Foundation. I think we could handle it that way.

Mr. JONES. Gentlemen, we are very grateful to you for your appearing before the committee and for the information you have supplied us, and I am sure that I speak for the chairman and the

other members of the committee, who have been forced to absent themselves before the conclusion of the hearings today.

Are there any further plans?

Mr. POLAND. There will be a hearing tomorrow, but that will not involve these gentlemen.

Mr. JONES. The hearing will stand adjourned until 10 o'clock tomorrow.

Mr. POLAND. In room 1537.

(Whereupon, at 11:55 a. m., the subcommittee recessed, to reconvene at 10 a. m., Friday, January 17, 1958, in room 1537, New House Office Building.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

FRIDAY, JANUARY 17, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND LEGISLATIVE
REORGANIZATION OF THE COMMITTEE ON
GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1537, New House Office Building, Hon. John W. McCormack presiding.

Present: Representatives McCormack (presiding) and Mrs. Harden.

Also present: Orville S. Poland, general counsel to the committee; James A. Lanigan, associate general counsel; William A. Young, staff consultant, and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK (presiding). The subcommittee will come to order.

We have as our next witness Peter J. Schenk, president of the Air Force Association. We are very glad to have you. Might I suggest that you put more of your background in, because I know you have a profound one. And while we know of it, that is, know the background in the scientific field, but for anyone who might read the record, when it is printed, in the years that lie ahead, it would be well to show your qualifications in your testimony.

BACKGROUND MATERIAL ON PETER J. SCHENK

Graduated from Lafayette College in 1941 with bachelor of arts degree in physics and military science; postgraduate study in political science and manpower management at George Washington University. In 12 years of active military service, assignments have included: Chief, Aircraft Warning Branch, Director of Communications, Headquarters, USAF; Air Force project officer for Project Charles and Project Lincoln; Vice Commander, USAF Cambridge Research Center, Cambridge, Mass.; executive officer to Lt. Gen. James H. Doolittle; executive officer to chief scientist of the Air Force; Assistant Military Director, Air Force Scientific Advisory Board; staff member, Ballistic Missiles Survey Committee; now lieutenant colonel, USAFR. Employed by the General Electric Co. since 1954.

STATEMENT OF PETER J. SCHENK, PRESIDENT, AIR FORCE ASSOCIATION; ACCOMPANIED BY JAMES H. STRAUBEL, EXECUTIVE DIRECTOR, AIR FORCE ASSOCIATION

Mr. SCHENK. I am Peter J. Schenk, of Santa Barbara, Calif., president of the Air Force Association. I am employed in the defense industry, and a consultant to the Scientific Advisory Boards of the

United States Air Force. However, I speak today only in behalf of the Air Force Association.

With me today I have Mr. James H. Straubel, the executive director of the Air Force Association.

As one who has been closely connected with scientific research and development for the last 17 years, 12 of these years in active military service, I take this opportunity to congratulate the committee on its examination of scientific research and development within the Government.

Our Nation is joined in a technological war with Soviet Russia. Whether we are ahead or behind in this new kind of war—at this particular moment—may be of less consequence than our relative position in the years just ahead. In scientific research and development we find the key to our future.

Hence the importance, in my mind, of the examination under way by this committee. Hence, also, the sense of urgency with which I present our views today.

As requested by the committee, these views will concern budgets, budgetary procedures, and organizational structures as they relate to scientific research and development in our Government.

Since national security is the primary interest of the Air Force Association, I will concentrate my remarks on military issues.

Scientific research and development is the foundation for new weapons. In turn, new weapons shape the future of the military services. Too often, weapon development, rather than strategic objective, is permitted to form the basis for mission assignment. In this situation, each service naturally tends to sponsor research and development programs pointed toward desired missions.

Therefore, I respectfully urge the committee to give full consideration to certain broad areas such as the assigned roles and missions of the services, and the overall structure of the military organization.

In this connection, I call the committee's attention to the policy statement adopted almost 18 months ago (in August of 1956) by the Air Force Association in convention assembled. It said, in part:

> Our present system of three separate military services compels patriotic men to strive for objectivity in an atmosphere of service partisanship. It induces jurisdictional disputes harmful to national security. It is wasteful of time, money, and manpower. * * * The goal must be one program for utilizing national resources in the national defense. We must have one defense plan. We must have a single military service with one secretariat, one Chief of Staff, one promotion list.

We still believe drastic reorganization of this type may be necessary for a full solution to the military research and development problem. However, I ask the committee to note that we have not recommended piecemeal reorganization of the military, as has become popular in recent weeks. In fact, we seriously doubt whether partial reorganization—such as a single Chief of Staff without a single promotion list—will do more than confuse the issue. Further, we would oppose any drastic reorganization except on an evolutionary basis—a step by step process geared to basic, agreed-upon objectives. Indeed, while such reorganization might have been a constructive move 18 months ago, as we then proposed, it might prove destructive at this critical point in our military history.

And it should be recognized that interservice rivalry has become a convenient whipping boy to cover up administrative bungling of many years standing in the defense program.

From this point on, I will be discussing the policies, procedure, and structure of our Government in existence today.

In the present system, we face glaring weaknesses in the procedures related to military research and development: in particular, the decision-making process.

Studies analyzing the life cycle of major military items have measured periods of creative technical work against periods of decision dead time—time during which progress was largely stopped while the technical team awaited approval or change orders from the cognizant Government agency. These studies concluded that as much as 50 percent of the total life cycle was consumed in nonproductive decision dead time.

We believe that the present sluggishness of the decision-making process results from two principal factors:

1. Overspecification—or the attempt to spell out in too much detail how development work should be performed, rather than to define the end result desired; and

2. Diffusion of authority—in that too many different offices or individuals must be consulted for necessary approval to proceed with a project.

In addition, the procedure of budget review has been permitted to exceed its proper role. For example, representatives of the Bureau of the Budget, with representatives of the Office, Secretary of Defense, theoretically review military programs only in relation to the overall national budget. Logically, it is the responsibility of the Bureau to be concerned with total cost rather than end items. In actual practice, however, it is not unusual to find the Bureau of the Budget making decisions which ignore or reshape the military requirement and run contradictory to the technical feasibility of weapons and supporting equipment.

One example involved a high temperature heating facility for which a military requirement had been established to pursue metallurgy and materials research for advanced weapons systems. The Department of Defense supported the requirement. However, representatives of the Bureau of the Budget decided that the high temperature heating facility was not required.

As a result, this project was deleted from the military research and development program. It is my understanding that this is not an isolated instance. I believe further examination by the committee of this entire procedure would prove of value.

As for budget policy, it has become commonplace in the past few years for the Office, Secretary of Defense, to establish budget ceilings for research and development before the military requirement has been established.

Faced with a growing technological dilemma, the Office, Secretary of Defense, has departed from its policymaking mission to become deeply engaged in military operations.

If the Advanced Research Projects Agency is established within the Department of Defense for space weapons development, we respectfully urge the committee to give it detailed consideration.

It has been indicated that this Agency would receive projects considered to be "not clearly the responsibility of a single military department. * * *" This implies indecision concerning assignment of responsibility for the space mission.

The United States Air Force has invested more than 50 years of hard-won experience pointing toward the space mission. From the time the first military airplane took off at Fort Myer, Va., command of the sky has been the primary mission of the Air Force.

Command of the sky always has meant getting on top—above the enemy. No one questioned the Air Force mission when operations reached 20,000 feet in World War II, 40,000 feet during the Korean war, or the operational altitudes of today. Scientifically, one cannot define exactly where space begins and atmosphere ends. Somehow, however, "space" is yet to be recognized as a simple extension of the Air Force's area of operations.

The Air Force already has left 90 percent of the atmosphere below it in current operations, leaving only 10 percent to be conquered for flights in space. Why should there be any question about the men, the concepts and the organization that conquered the 90 percent—step by step? Why is it different, from a mission standpoint, to be on top of an enemy at 40,000 feet or from the vantage point of a space station on the moon? Why should there be any indecision regarding the space mission of the Air Force? These, we submit, are questions worthy of the committee's consideration.

Regarding the Advanced Research Projects Agency, it is also indicated that as weapons or systems developed by the Agency approach the point of operational use, they will be phased into the operation of one or more of the military departments in an orderly fashion.

We believe it highly questionable that a staff agency of the Department of Defense, divorced, as claimed, from operating resources, simply can "phase" new developments into the military operation without wasting time, money, and manpower. All experience in ballistic-missile development proves that operational elements such as ground support, equipment, logistic support, training, production, and logistics must be intimately linked to the research and development effort. In light of this, we respectfully urge the committee to investigate the problem.

As a basic objective, we hope the committee will consider a general relaxation of both detailed and centralized control over military research and development. Let us look, first of all, at basic research.

Here the taxpayer is buying competence. He is buying a potential, hoping for the acquisition of new knowledge which may or may not find application in weapons.

Thus, the main job is to induce competent men to work in scientific fields which can reasonably be expected to deliver some benefits to the national defense.

In general, there has not been enough Government support for basic research, despite the fact that it is relatively inexpensive.

Basic research should be sponsored by a number of Government agencies with no fear of causing duplication, because the objective is to stimulate and support the work of every competent research team whose interest can be aroused. Further, this type of activity has not been sufficiently rewarded in money or prestige.

For applied research and development, where a larger effort is required and the cost becomes correspondingly larger, we recommend

two departures from current management principles: First, budgeting for the attainment of stated objectives rather than on a fiscal year basis, with the funding subject to cancellation only if the objective turns out to be technically impossible or the requirement disappears. This would permit orderly planning and scheduling of manpower throughout the life of a program. It would allow acquisition of facilities and material at the most efficient and economical rate.

Second, we recommend a change in the present practice of splitting up research and development budgets in tight little compartments. This practice makes it very difficult to allocate—in adequate proportion—the manpower, materials, facilities, and administrative support necessary to research and development projects.

Only by budgeting in advance for stated objectives and giving the director of the program freedom and flexibility in the use of his allocated resources, particularly funds, can we hope to make the maximum progress possible.

Beyond that, it becomes fundamental that we establish a climate for the conduct of military research and development which will permit this Nation to make maximum use of its vast resources of brains, money, facilities, and materials for defense purposes.

For example, we believe that the present system of security classification of technical information, especially the "need to know" principle, is doing far more harm to our own technological progress than the good it might once have done in denying important information to a potential enemy.

The present security program is a jungle of innumerable laws, Executive orders, regulations, practices and procedures, subject to conflicting interpretation and administered by an assortment of agencies and bureaus.

There are no national standards covering all aspects of the security program applicable to Government, industry, and universities. There is no truly comprehensive "central index" whose certification of security clearance is accepted by different agencies.

What is badly needed is a solid, well-reasoned security program based on specific congressional legislation to lay down policies and principles, with uniform implementation through proper rules and procedures. We need a program founded on law, rather than the unilateral actions of Government agencies.

Specifically, we recommend the establishment of a new type of clearance for individuals of unquestioned loyalty and integrity who would be given broad access to classified technical information—although not necessarily information involving military operational plans, nuclear stockpile quantities, etc.

With this clearance, freed from the "need to know" restrictions, scientists and technicians would be able to unchain important technical capacities now locked up by isolation from the problems and achievements of other workers in the field.

Another important aspect of the security information problem is, of course, the public release of information about our technical achievements. However, we must do more than keep the American people informed. As a major engagement in the technological war, we must learn to make imaginative and efficient use of our military research and development program in the continuing and vital struggle for world opinion.

In addition, we must restore our national heritage of pioneering. Much of the research and development work currently sponsored by the Government on a cost-plus-fixed-fee basis results in unimaginative and safe approaches.

The rewards for daring are small in comparison with the penalties for failure. There is no real incentive for doing an outstanding job, hence little inclination to gamble and take big risks. The profit ratio is very small in comparison with the profit ratio for comparable work in the civilian economy.

With no true incentive for superior performance, human nature will prevent the application of superior talents, as long as greater rewards are available elsewhere.

It is true that outstanding performance of research and development work on a cost-plus basis may place an organization in a preferred position for a follow-on production contract. However, there may well be little relation between the production competence of a company and its ability to perform research and development.

Thus, it becomes necessary to treat research and development as an end in itself, and to properly reward superior performance. This would have the advantage of focusing on military research and development problems the minds and talents of outstanding men not now associated with these problems.

Finally, on a broader front, we face the dilemma of the day. Why must we strain to match the achievements of the Soviet Union in military research and development when we enjoy unquestioned world leadership in the research and development of products and services for the civilian economy?

Our free-enterprise system is by far the most effective economic philosophy that has been devised by mankind. Free enterprise, however, is based on competition, innovation, and the incentive of profit as a reward for performance—profit which increases with quality, and retained profit which in turn makes possible innovation, expansion, and price reduction.

Yet, when we come to national defense we depart radically from this principle. We immediately begin to regulate, centralize, control prices, and especially profits, and subsidize on a vast scale.

We give here and take there with a web of administrative controls in a system that, on the whole, follows socialistic philosophy more than free enterprise. Little wonder that we cry for "czars" when we find ourselves in difficulty with a defense competitor, like Soviet Russia.

Realizing that a large and costly defense program appears to be a continuing necessity, we may now be able to consider for the first time, fundamental changes in our approach to providing new weapons. We may be able to treat defense work as a business instead of an interruption of business.

Certainly it is well to remember that America was pioneered by men who translated the free enterprise system into action, often at great risk, and equally often with great results.

Somehow, the pioneering spirit must return to America. The hour is late but the path is clear. We can and we must apply our total potential to the technological war. We must unleash the tremendous reservoir of American know-how to keep our country free.

In conclusion, Mr. Chairman, I call your attention to a staff study

appearing in the December 1957 issue of Air Force magazine, published by the Air Force Association. It is titled "Organizing for the Technological War."

It presents further analysis of Government research and development, including specific recommendations for corrective action regarding the budget, facilities, administrative environment, and organization. In the belief that it is worthy of the committee's consideration, I respectfully request that this report, Organizing for the Technological War, be inserted into the record of the committee as a supplement to my testimony.

Mr. McCormack. Without objection it is so ordered.

(The article referred to is as follows:)

[From Air Force magazine, December 1957]

ORGANIZING FOR THE TECHNOLOGICAL WAR

An Air Force magazine staff study

The material on the following pages was written during the period between the advent of Sputnik I and the first of the series of speeches by President Eisenhower on November 7. It represents the distillation, however, of several years of study, discussion, rumination, and research. It is presented as neither bible nor blueprint but as a basis for serious thought and analysis for those who see the recent Soviet technological achievements as the very real threats to our national survival that they are—and also for those who may still be laboring under the delusion that all is well. "Blood, sweat, toil, and tears," was the Churchillian promise. Let us hope that with the prompt application of sweat and toil to the problem at hand we and our children may yet escape the blood and the tears.—THE EDITORS.

Since 1907, America, the birthplace of aviation, has three times lost its qualitative air leadership. The first loss began almost immediately after the Wright brothers' success and continued through World War I, when not an American designed and built warplane saw combat. The second was in the waning months of World War II, with the appearance of the German V–1, V–2, and ME–262 jet fighter. The third was in early October 1957, with the announcement of the launching of Sputnik I by the Soviets.

The world has now entered upon the scientific age, marked by a technological war between the United States and the U. S. S. R., in which the Soviets are currently gaining by an inspired pioneering spirit, and by our default. Since the end of World War II, Soviet science has forged ahead unrelentingly. During the same period, American science has been bogged down by a bureaucracy which places major emphasis on economy and redtape and little emphasis on results.

As a nation, we were once proud of our pioneering and adventurous spirit. Today, our scientific pioneers spend most of their time and energy fighting for adequate budgets and submitting progress reports.

The race for the conquest of space is today's major engagement in the technological war. And we must win it, for the nation which dominates space will be in a position to dominate the world.

Furthermore, we are in a dynamic situation in which science is creating new threats to our security faster than it can develop adequate countermeasures. Thus, at some point, the loss of a significant engagement in this war may prove fatal. In short, either the United States promptly goes ahead in the technological war and stays there, or human freedom will eventually succumb to Communist tyranny by default.

THE PROBLEMS

At present, we are taking unprecedented risks with our national existence because only a few of our political leaders understand the impact of science on our security, industrial growth, and way of life.

As a result, the following things appear to be true:

1. We are becoming a nation of timid, unimaginative people. The emphasis is on "safe" men, not on pioneers. The rewards for daring are small, in comparison with the penalties for failure.

2. The decision-making machinery of the Government bogs down because many problems have a high technical content, which many Government officials do not understand and hence cannot evaluate.

3. Many national policy decisions of profound importance are made by default at the working level, without ever being considered by the National Security Council.

4. When the NSC does consider an important problem with high technical content, it generally does so only after the problem has become a crisis.

5. Instead of "security with solvency," we are heading toward insecurity and waste, because we have not adjusted our defense organization to the incredible advances in weapons technology.

6. We have not fully comprehended the scientific (as well as political) interdependence of the free nations, and we have not integrated our technical effort with that of our allies. As a result, we have not taken full advantage of allied scientific and technological capabilities.

7. The American people have not been given an adequate understanding of the technological war and of its growing demands for resources. While justifiably concerned about security information, we have oscillated wildly between two extremes, either making boastful claims or not saying anything. We still talk too much, but we don't say enough, and we are misguiding the American people in the process.

8. Even after Sputnik I showed us how wrong we were, we continued to overlook the psychological impact of technology upon world opinion and were caught flatfooted by Sputnik II. We knew the anniversary of the Red revolution was on the Soviet calendar. One wonders why we were unable to plan a spectacular achievement for announcement on November 7, to take the psychological initiative for a change.

This is no time for panic; it is a time for sober thought and sound action. For either we accelerate the quality and pace of our scientific effort, or we enter upon a period of steady decline in our relative strength, which can only end in our eventual extinction as a nation.

STATESMEN, SOLDIERS, AND SCIENTISTS

Since the end of World War II, statesmen, soldiers, and scientists have tried to come to grips with problems of unprecedented complexity, arising from the ever-faster pace of the age of science. However, even though outstanding men in all walks of life have worked together devotedly for the welfare of the Nation, our ability to cope with such problems has deteriorated.

Scientists have participated in Government policymaking largely only as advisers, when invited. Final decision making has remained mostly in the hands of the lawyer, businessman, or soldier. There has been one important exception to this statement. The Atomic Energy Commission has never been without at least one outstanding scientist; the present scientist-member has been, on occasion, Acting Chairman of the Commission.

In other fields, just as important as atomic energy, scientists have rarely held jobs at Government policymaking levels. And, unhappily, there have been few Government officials who have taken an active interest in scientific progress and in its implications. It has been said that the last President of the United States to sit down at dinner with the National Academy of Sciences was Woodrow Wilson in 1918.

Thus, more often than not, we have had no real dynamic leadership in science. Rather, we have had decisions based on that part of some scientist's advice which is easiest and cheapest to follow.

In part, this stems from the unwillingness of scientists themselves to assume greater responsibility for the consequences of their work. And, in the largest part, it is the direct result of an educational system which brings up children with little knowledge of science, but with a conviction that God has forever ordained our scientific leadership, rather than teaching those children that our great scientists and our great scientific discoveries have been largely imported from abroad.

Some statesmen have belittled the relationship between science and national strength. Others have assumed that a scientist trained in one field is automatically an expert in all sciences. Some military men have been hesitant to

embrace science's new ideas and new weapons. Others have used scientists as professional "ax grinders" for a particular service's point of view. Some scientists have cloaked with scientific infallibility both their rather naive nonscientific views on nonscientific questions, as well as their judgments on scientific questions in fields outside their area of competence. Others have tried to maintain that scientists have made no mistakes, and that it is somehow wrong to admit that they have.

It is not suggested that all statesmen and soldiers abdicate, and let the scientists take over. Few scientists have the desire or aptitude to hold top positions in the administrative and policymaking field in government. But there is a crying need for men in such positions who have a scientific background, who understand scientists and how to work with them, and who know how best to make use of scientific advice.

More scientists should be integrated, where appropriate, into the working structure of Government, particularly in the executive branch, as well as in the Congress. Furthermore, among those scientists working for the Government must be men who understand the dominant technologies of our time. Today, one of the most important of these is the technology of aeronautics.

The White House

Corrective action must begin with the White House itself and the President's Science Advisory Committee.

Up to the present, even though the Chairman has a direct line to the President which he can use if he wishes, this Committee has generally waited for the President to ask it to do something. Since Presidents have little time to develop an understanding of science, they don't know when to ask for help and advice, or what to ask, for that matter. Thus, usually, someone on the "working level" must "maneuver" for months to get the President to ask the Committee to study a scientific problem that may have been crying for attention for years.

When the Committee has been called on for assistance, the problem has generally been too narrowly defined, and many recommendations have gone unimplemented for budgetary reasons. Mostly, the Committee has studied narrow military problems, rather than such major questions as the adequacy and effectiveness of the entire national research and development effort.

For all of these reasons, in spite of a few outstanding contributions, the Committee has been passive and only partially effective.

The Committee must be revitalized, and its membership, mature in judgment but hard-pressed for working time, supplemented by working groups of younger men like those who came out of our scientific efforts in World War II. Furthermore, more of these men must understand the dominant technologies of our time (e. g., only one man on the present committee is an aeronautical scientist).

The Committee must undertake studies of national importance on its own initiative, and it must be given to understand that the Chief Executive would welcome such action. Right now, the Committee should take on a broad study of action required to insure our survival in the technological war.

The study should include these major areas:

Attracting greater numbers of qualified young people to the study of science;

Insuring that scientists understand political problems and know how to communicate with their fellow men;

Insuring that every graduate in the arts, letters, law, medicine, and so forth, is not completely ignorant of technical matters;

Improving the economic and social stature of teachers and professors;

Reorganizing the national scientific research and development effort to place emphasis on achievement, rather than administrative tidiness;

Insuring that security regulations do not smother technological progress;

Insuring the adequacy and effectiveness of the entire research and development effort;

Drastically modifying the overcentralized bureaucracy in Washington, which has our military and industrial scientists spending most of their time making budget presentations and writing progress reports;

Reducing lead times required to bring new weapons and ideas to operational and full use;

Infusing the entire structure of government with more adequate numbers of men who understand the dominant scientific trends of our time.

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The Cabinet

Most Cabinet discussions of technical problems are conducted by technically uninformed people. This is dangerous for the Nation. The same is true on the sub-Cabinet level.

For example, most of the national defense budget during the past 5 years has been spent on aviation. Many of the great airpower leaders in the Nation have been lifetime Republicans. Yet, not one of them has been asked to do a Cabinet-level job, with the exception recently of the Special Assistant for Aviation Facilities Planning.

At least one Cabinet-level officer should be an outstanding technologist-statesman.

Initially, this Cabinet-level officer might be a Special Assistant to the President for Science, with membership on the National Security Council and the President's Science Advisory Committee. Eventually, it might prove wise to set up a Department of Science, with Cabinet representation.

The science Cabinet officer would become the focal point for formulating national science policy, and for such agencies as the National Science Foundation, National Bureau of Standards, the NACA, and similar organizations.

The recent appointment of Dr. James R. Killian, president of the Massachusetts Institute of Technology, as Special Assistant to the President for Science and Technology, is indeed a welcome first step toward full-fledged representation of science at the Cabinet level.

National Security Council Planning Board and Staff, Operations Control Board, and State Department Planning Group

None of these organizations has enough people who understand the impact of science on national policy. For example, the implementation of a United States aerial surveillance program has lagged terribly. First, it took years to "sell" the program and explain its importance. Then, budgets to develop the necessary equipment were not forthcoming. Various officials trembled at the thought of sending up a United States satellite whose orbit might intersect the space over Soviet Russia. While we debated, the Soviets went ahead and did it, and the military, political, and psychological consequences are now well known.

Top-caliber technical people should be promptly added to the staffs of each of these agencies. The present practice of using ad hoc groups of consultants to study complex technical problems under the aegis of the NSC should be continued. The full-time technical staff members would insure that such ad hoc studies are started on time and that something constructive is done with the results.

Joint Chiefs of Staff

There are two impasses at this level.

The first has to do with the impact of science on strategy and war planning. At the present time, the Joint Chiefs are advised on science by people who tend to present the narrow point of view of a particular service. The Joint Chiefs of Staff should be advised by a few outstanding, independent scientists, who can lay technical facts on the line, regardless of the impact on any specific service. Such scientists should, above all, be wise, objective men, who will stick to their own fields of competence, get additional help where they need it, and not become scientifically trained "ax grinders."

The second problem has to do with the Weapon Systems Evaluation Group, which was set up some 10 years ago to assist in the selection of weapon systems which represent "maximum combat effectiveness" at minimum cost.

All three services have contributed to keeping this organization largely ineffectual.

Recently, steps have been taken to strengthen WSEG, by recruiting scientists in more adequate numbers, and by giving the group an independent and strong board of trustees, many of whom are outstanding scientists. These steps, taken through the creation of the Institute of Defense Analysis under WSEG, should be further accelerated.

WSEG is supposed to be able to spend 20 percent of its effort studying problems on its own initiative. Actually, the present small organization has never been strong enough to complete on a timely basis the many studies which the Joint Chiefs and Defense Secretaries have asked it to perform. Furthermore, congressional sniping and budget cutting have already begun to inhibit the growth of WSEG.

WSEG is one of the principal keys to the elimination of obsolescent forces, which load on the taxpayer an additional bill for equipment which will never

be used in combat, WSEG can also foster the more rapid development of weapons which promise greater combat capabiilty per defense dollar.

Both the executive and legislative branches of the Government have a major stake in accelerating its effectiveness.

Department of Defense

There are four basic problems which must be solved in the present organization of the Department of Defense.

First, the Joint Chiefs of Staff organization must be reoriented, to make possible war planning and force level determinations in an atmosphere of national interest, rather than service interest.

Second, the Defense Department organization must be streamlined, for the reasons outlined in the 1956 Statement of Policy of the Air Force Association, which said:

"Sweeping revolutions in weapons technology have outmoded our country's traditional approach to national security. If we are to achieve security with solvency, fundamental changes must be made in our Military Establishment.

"Our present system of three separate military services compels patriotic men to strive for objectivity in an atmosphere of service partisanship. The system too often ties military careers, and therefore military operations, to obsolescent weapons and concepts. The system encourages the postponement of basic decisions by piling compromise on compromise, committee on committee, It includes jurisdictional disputes harmful to national security. It is wasteful of time, money, and manpower.

"The three-service system can no longer be tolerated. The goal must be one program for utilizing national resources in the national defense. We must have one defense plan. We must have a single military service with 1 secretariat, 1 Chief of Staff, 1 promotion list.

"We must achieve this singleness of purpose, organization, and operation at the earliest possible moment. We must achieve this goal without compromising essential competition of ideas in defense planning and weapons development, while eliminating uncontrolled and wasteful competition for scarce manpower, money, and material."

Third, the Armed Forces must be reorganized for specific military tasks, rather than around means of locomotion; i. e., ground, sea, and air. The present roles and missions have been obsoleted by spectacular advances in the reach and destructiveness of modern weapons. (See How the Soviets Run Their Missile Program, by Dr. Raymond L. Garthoff, p. 53.)

Fourth, the military research and development effort of all three services must be freed from the shackles of bureaucracy, and placed in an administrative framework in which the emphasis is on achievement and the required resources are more readily provided. This must be done in a manner which retains constructive technical competition in research and development. At the same time, wasteful political competition must be ruthlessly eliminated, and a mechanism provided to insure that new weapons are selected for production on a "maximum effectiveness at minimum cost" basis.

The problem of military research and development has special significance in the face of mounting evidence of Soviet progress in new weapons technology. Accordingly, this paper limits its specific discussion of Department of Defense problems to those having to do with research and development.

Military research and development (R. and D.)

The basic needs of R. and D. can be simply stated: competent men, money, facilities, proper administrative environment, and sound organization.

COMPETENT MEN

With the end of the war, the National Defense Research Council, Office of Scientific Research and Development, was disbanded. The Nation's outstanding scientists, who had so ably managed wartime development of the atomic bomb, radar, proximity fuses, etc., returned to their universities and research laboratories. Simultaneously, with explosive demobilization, the three services lost many of their military and civilian technical men, who did such an outstanding R. and D. job during the war in fields such as aviation, which were not covered by the NDRC–OSRD.

Since then, only a few outstanding scientists have been willing to accept full-time assignments in military research and development. For example, a major fraction of all past military research and development budgets has gone into the field of aviation; yet, an outstanding aeronautical scientist has never been

the top defense official for research and development. Similarly, although the three services have been working hard to improve their military and civilian technical staffs, inadequate military personnel policies and salaries and the outmoded procedures of the Civil Service Commission have made progress extremely slow.

On the national scene, the Bureau of Labor Statistics put out a report in the late 1940's which said, in effect, that there was a glut of scientists and engineers. Ironically, during this same period, the military research and development budget was being limited because of an alleged shortage of scientists and engineers.

The Soviets are now training scientists and engineers at about twice the United States rate. As long ago as 1952, then Under Secretary of the Air Force Roswell A. Gilpatric warned that, unless we stepped up training of scientists and accelerated the pace of our research and development effort, we would, eventually, lose the race for qualitative supremacy of weapons to the Soviets, by default. We are now in the process of seeing this happen.

There is no easy solution to the shortage of trained scientists. Many of the things which might be done are mentioned above, as items for study by the President's Science Advisory Committee.

Certainly, we must make science careers much more rewarding than they presently are. The Soviets have far outstripped us in this field, as is witnessed by the social and economic prestige they accord their scientists. Awards and recognition such as the Fermi prize, now awarded annually by the Atomic Energy Commission and the atoms-for-peace prize of the Ford Foundation should be extended into other scientific fields besides atomic energy.

RESEARCH AND DEVELOPMENT BUDGET

The military research and development budget has been inadequate every year since the end of World War II, with the exception of the calendar years 1950–52. Furthermore, we have twice made a fundamental blunder in equating a stable research and development program with a constant research and development budget. In fact, so long as the Soviets choose to engage us in an armaments race, the military research and development budget must continue to rise steadily, in pace with the Soviet effort.

The reason for this is simple. Each successive generation of weapons has better performance, to match the gains being made by the enemy. These performance improvements are bought by geometric increases in the cost of prototypes of miiltary hardware. Thus, if the research and development budget remains stable, we reach a point where we can no longer initiate new prototypes.

This happened during the Johnson economy era, prior to Korea. For some 2 years, the Air Force did not have enough research and development dollars to lay down any new prototypes. We went into the Korean war with only one fighter capable of matching the Soviet MIG–15. That fighter, "our" F–86 Sabre, was equipped with a jet engine designed by the British, and a sweptback wing designed by the Germans.

The same thing has happened since 1953. In spite of the fact that it appears otherwise because accounting procedures have been changed periodically, the research and development effort has been slowed down over the past 5 years. For example, the dollars for Air Force research and development work in industry during the current year were programed at some $120 million less than they were during the last fiscal year of the Truman administration.

The figures put out recently by the National Science Foundation on the national research and development effort are helpful in considering this problem. Whereas the gross national product has grown about 4 percent per year, the total research and development effort of the Nation (for both civilian and military purposes) has increased by about 13 percent each year.

This basic statistic is enormously important. It indicates that, as the world gets more and more complicated, it takes a progressively greater effort to invent new things. Thus, if we wish to stay ahead of the Soviets, we cannot solve our shortage of scientists and engineers by cutting down on military research and development programs and discharging technical people, as we are now doing.

Rather, we should be stepping up both technical training and our military research and development programs.

In the field of military aviation, the present research and development budget is inadequate by a figure of perhaps $250 million per year. If the Soviets choose to continue the armaments race, it is not unreasonable to foresee a military re-

search and development program in aviation alone amounting to as much as $5 billion per year by 1975.

There appears to be a misconception in the executive branch of the Government that industry should "foot the bill" for military research and development. This should and can be done, to some extent, in fields such as electronics. In aviation, it simply cannot be done, for two basic reasons:

First, commercial sales of aircraft do not produce sufficient profits to let industry support military research and development programs.

Second, profits on military production contracts are too small, industry's research and development charges against those contracts are mostly disallowed, and the Treasury Department has been reluctant to allow tax writeoffs on industry dollars spent for new prototypes.

Actually, it would take more than the entire net worth of the aircraft industry to support the military research and development program for 1 year at its present rate.

The military research and development budget must increase steadily, so long as the pace of the research and development effort of our Soviet competitors continues to accelerate.

The Secretary of Defense should submit promptly to the NSC a statement of additional research and development budgets required.

The objective should be to outpace the Soviets in aeronautical technology. No artificial guidelines, limiting in advance the money to be requested, should be imposed on the Defense Department.

RESEARCH AND DEVELOPMENT FACILITIES

Regarding research and development facilities, a long time cycle is involved in getting major construction programs approved by the Pentagon, and getting authorizing legislation and appropriations passed by the Congress, as part of the public works program. As one example, let us take the engine test facility (ETF) at the Arnold Engineering Development Center (AEDC), in Tullahoma, Tenn.

The ETF is capable of testing full-scale jet engines under simulated flight conditions. The basic facility was designed and constructed in Germany, and was operating in Munich in 1945. There are many horror stories about how long it has taken the Soviets to reassemble various industrial plants, either purchased or seized abroad. In this case, and in many others like it, the United States out-Russians the Russians.

In spite of the almost frantic efforts of the Air Force, the engine test facility was not put into operation again until 1953, some 8 years after it was taken over from the Germans.

During this period, American airpower was severely handicapped due to a shortage of full-scale jet engine test facilities. We got off to a late start in the development of jet engines, after the war. Many aircraft were lost due to jet-engine failures, at a cost of many lives and millions of dollars.

The entire cost of building full-scale engine-test facilities could have been amortized for a fraction of the cost of jet aircraft lost. Yet it required an incredible administrative struggle, lasting many years, to get program and budget approvals.

The story repeats itself in the case of practically every large military research and development installation constructed by the Government. It is a dreary story, in which our military and civilian scientists see their projected and urgently required facilities slowly grow obsolsecent, while they struggle and wait for program approval.

A joint task force, composed of representatives of the Department of Defense, Bureau of the Budget, and the Military Affairs and Appropriations Committees of both houses of Congress, should study this problem and recommend appropriate action at an early date.

RESEARCH AND DEVELOPMENT ADMINISTRATIVE ENVIRONMENT

The post-World War II economy era forced the Defense Department's Research and Development Board (RDB) to place major emphasis on "policing," i. e., to prevent duplication. As the fight over unification emerged, the three services began staking out their future in the fields of new weapons development. This made the policing function of the RDB all the more difficult. At one point, the RDB had an organization of several hundred committees, panels and subpanels, and several thousand consultants, enmeshed in organizational

procedures which sometimes required as much as 2 years for approval of a major research and development program.

During this same period, the Office of the Assistant Secretary of Defense (Comptroller), the Bureau of the Budget, the General Accounting Office, and the Comptroller General gained strength and began exercising more control over research and development projects. Simultaneously, armed services procurement regulations and property accounting procedures were rewritten, often adding to the administrative redtape involved.

Thus, while the top defense research and development organization was engaged in a futile attempt to achieve a degree of coordination which the three services were organized not to permit, an amoebic bureaucracy slowly enmeshed the research and development organizations of the Army, Navy, and Air Force.

This brief historical note leads to one basic point: if the Department of Defense is reorganized to eliminate undesirable competition among the three services, the major reason for the myriad of centralized controls imposed upon the military research and development effort by the various arms of the executive branch of the Government and the Congress will have been eliminated. It should then be possible to construct anew a proper administrative environment for military research and development.

RESEARCH AND DEVELOPMENT ORGANIZATION

There have been two schools of thought on the research and development organization. One has maintained that a civilian-type organization should be set up outside of the Department of Defense, similar to the British Ministry of Supply. The other has contended that the military must retain control of the research and development organization, using civilian scientists only as employees and consultants.

What actually is needed is a mixed organization, composed of military and civilian scientists, in which people are assigned solely according to their technical and administrative competence.

The military man brings to the job a sense of mission born of the knowledge that he may one day have to fight and die using the weapons that come out of his research and development effort.

The civilian scientist can bring to the military reconstruction and development effort a level of scientific training and insight which has been achieved by the military man only in rare exceptions. Both civilian and military scientists are essential to the task. One canot do without the other. The basic need is to create a unique administrative environment for military research and development first, as recommended above. Then, almost any reasonable organization will produce results.

The urgency of an increased effort in this field, thanks largely to sputniks I and II, is now generally acknowledged. By and large, our shortcomings in this vital field would be overcome, should the reorganization suggested in the preceding portions of this article come about. For, as Trevor Gardner has pointed out in a recent Life article, we have bogged down in missiles and satellites because of (1) inadequate funds and (2) an administrative jungle of government by committee.

The President's action in designating Assistant Secretary of Defense Holaday as the Pentagon's missile czar is encouraging. But it must be made clear that Mr. Holaday is, in fact, a decision maker and not a coordinator, that he is, indeed, "clothed with all the authority the Secretary himself possesses in this field, so that no administrative or interservice block can occur." One way to insure this would be to designate Mr. Holaday's job as that of Deputy Director of Defense for Missiles.

There are additional problems, if we are to meet successfully the challenge of the technological war. One is covered in some detail in the statement issued by the board of directors of the Air Force Association at Colorado Springs on November 2. It concerns the need for maintaining an informed and enlightened public without jeopardizing true military secrecy. The other is the need, expressed by the President, for the pooling of the scientific resources of the entire free world to meet the threat of the burgeoning technology from behind the Iron Curtain.

It all adds up to a tremendous undertaking with short-term, decisive action coupled with long-range reorganizing and planning. One will not do the job without the other.

The foregoing is presented, not with the idea of being a panacea for all our scientific ills, but with the thought that we cannot meet the Soviet challenge with-

out first recognizing the magnitude of the task facing us. Then we must demonstrate our willingness to pick up the technological gauntlet which the Soviets have flung at our feet, else we inevitably will lose the freedom which was purchased for us by the blood and sweat of our forebears.

Mr. SCHENK. I wish to express my thanks for this opportunity to appear before you in behalf of the Air Force Association. Thank you.

Mr. MCCORMACK. Are there any questions?

Mrs. HARDEN. I thank you, Mr. Schenk, for appearing before our committee. I found your statement very interesting and informative. I haven't any questions at this time.

Mr. MCCORMACK. Mr. Poland?

Mr. POLAND. One of the things that you stress, Mr. Schenk, is the interruption and difficulty in putting into effect research programs. Yesterday we heard some testimony about the application of systems analysis of these problems. Do you feel that a continued program of systems analysis would help expedite this?

Mr. SCHENK. Yes, sir. Systems analysis is a term which covers a variety of activities. And I am afraid that I do not know precisely the meaning that was attached to it in the testimony yesterday. If the words "systems analysis" were meant in the sense of analyzing a military requirement, and organizing the supporting technology which would be needed in order to fulfill this requirement, I think this is a very useful and, indeed, a necessary function in carrying out military needs.

I would caution that there has been a tendency not to support sufficient general research which fills up the storehouse of knowledge, because there has not been an obvious military occasion for it.

Mr. POLAND. You are speaking there of basic research when you use the term "general research," are you?

Mr. SCHENK. Yes; basic research, general research, exploratory research, in the sense that it is not aimed at the solution of an immediate and foreseeable problem.

Mr. POLAND. I understood your testimony to be to the effect that, as I read here—

basic research should be sponsored by a number of Government agencies with no fear of causing duplication.

Mr. SCHENK. Yes.

Mr. POLAND. We had some testimony to the effect that the people who are competent to do real basic research are widely distributed in universities and elsewhere, and they, themselves, are the best source of information as to what the next field of endeavor should be in basic research. How are you going to accomplish your purpose unless you go to universities and other places where the researchers are and lift not only their working ability but their knowledge in the fields to be explored?

Mr. SCHENK. Well, sir, I would agree with what I understand you to say of yesterday's testimony—that this research should well up from the grassroots, where the competence is, in the scientific community. And I believe that the best way to make sure that every potentially useful idea is adequately supported is to have a number of agencies in the business of supporting it, so that if, let us say, a professor at a university has a good idea, and he goes to one Government agency and is told: "Sorry, we are temporarily out of funds," or, "We are not

interested in that," he can go elsewhere and get it supported there, and, actually, he will find a means of coupling to the Government structure to get the necessary support.

Mr. POLAND. Do you not feel that there is sufficient cross-fertilization of ideas amongst the scientists so that they should be sufficient, through one agency, to open up all of the sources?

Mr. SCHENK. I think, as a general principle, that the more cross-fertilization you have and the less funneling through a central point, the more information is going to be exchanged. Let us free the channels of communication in all directions.

Mr. POLAND. I have only one other question, Mr. Chairman, and that relates to the budgetary comment that you made, in respect to the cancellation of projects.

Mr. SCHENK. Yes, sir.

Mr. POLAND. Did you mean cancellation because of the expiration of the appropriation, or did you have any reference to cancellation that might result from a quarterly allocation of funds?

Mr. SCHENK. Well, sir, the specific point I was trying to get at in my testimony was this: Often, after a military requirement has been established and a military justification rendered for conducting a piece of technical work, the budgetary reviews are conducted, generally speaking, by people not trained in the technical content of the program they are looking at. As a result, somewhat arbitrary decisions have been made to single out a particular item and strike it from the approved program, and the technical program has become unbalanced. Other things left in the program might have depended, for complete success, on the thing that was stricken out. By this random intervention from an outside controlling influence, technical programs have been disturbed and weakened.

Mr. POLAND. Should we understand your testimony to include in that random intervention that it would include both the Department of Defense and the Bureau of the Budget?

Mr. SCHENK. I think, probably, at one time or another, almost every agency has been guilty of doing this, sir.

Mr. POLAND. I cannot put my finger on the point, but I think I recall your having said in the Department of Defense they established budgetary ceilings rather than technical requirements in consideration of their own budget before it went over to the Bureau.

Mr. SCHENK. Yes, sir. I believe that is correct.

Mr. MCCORMACK. At the bottom of page 4, you will find that. There is a reference to that, the last paragraph which reads:

> As for budget policy it has become commonplace in the past few years for the Office, Secretary of Defense, to establish budget ceilings for research and development before the military requirement has been established.

Mr. SCHENK. If I may elaborate on that, sir: What has happened is that the Office of the Secretary of Defense has gone to the individual services and said, "You may spend this much money in this particular category of endeavor." In effect, therefore, establishing a ceiling before the military requirement has been transmitted to the Office of the Secretary of Defense.

I must say this, sir. I have not been in active military service for almost 4 years and, consequently, some of these things of which I speak as having taken place during my own experience may have changed in the intervening 4 years.

Mr. McCormack. Mr. Lanigan.

Mr. Lanigan. I have one question about your statement in which you indicated that you thought that space travel and space work was a proper function of the Air Force. However, in this article which you put in the record, under the heading "Department of Defense," the Air Force Association stated that—

> the Armed Forces must be reorganized for specific military tasks, rather than around means of locomotion, that is, ground, sea, and air. The present roles and missions have been obsoleted by spectacular advances in the reach and destructiveness of modern weapons.

Has the Air Force Association changed its opinion with respect to this statement?

Mr. Schenk. No, sir. I think I can see what the possible confusion is. What we said and what we meant in our original article was this: We believe that the services eventually should be reorganized around missions. We regard the mission of the Air Force to be control of the sky and an extension of this to be control of space.

You might use all kinds of vehicles in the process: Guided missiles, manned space scraft, and transitional vehicles like the X–15 which look like conventional airplanes but go into space. We think this is consistent. I repeat—we think it is consistent.

Mr. Lanigan. Isn't another mission control of the sea? Why wouldn't you keep a Navy to control the sea?

Mr. Schenk. We would. We believe that control of the sea is a legitimate mission, and we note that in controlling the sea the Navy uses many kinds of vehicles. It uses aircraft to exercise surveillance over the sea, ships on the sea, and submarines underneath the sea. But its mission is control of the sea.

Mr. Lanigan. So you would not argue that the Navy should not have its aircraft at its disposal?

Mr. Schenk. No, indeed; we would not.

Mr. Lanigan. Can you clarify a little more what you mean by this recommendation regarding missions rather than means of locomotion?

Mr. Schenk. Well sir, at the moment, for example, there is a joint command, the Continental Air Defense Command. This command has a mission to protect the North American Continent against attack through the air.

This command has in it units of the present Army, the present Navy, and the present Air Force. It is truly a mission oriented command. We believe that this is in tune with the times and is a most efficient philosophy of organization for the military services.

I believe that there has been a very fine discussion of this whole problem in the Rockefeller report which was recently made public. And I would refer you to that report for a discussion and a statement of this particular problem, which is exactly as the Air Force Association sees it at the present time.

Mr. Lanigan. Well then, if you have a mission oriented command that would leave research and development as a function outside of any particular mission, wouldn't that leave research and development as a separate mission in itself?

Mr. Schenk. Research and development is too broad a term at this time. Here I would like to draw a distinction between basic research and weapon development that is uniquely aimed at the task of one of these mission oriented commands.

I would say that in the long pull—and we are now talking about a future goal of reorganization of the Military Establishment—there is room for a basic research controlling agency. "Supporting agency" would be a better term, because it should not control very much. It would administer the funds and stimulate the work. The results of the work would be made available to development agencies.

I believe that there must be a very close tie-in between the using commands and the developing agencies which provide weapons for that using command.

I think it would be wrong to have a single agency which is responsible for developing all new equipment for everything, because I think there must be a closer tie-in between the users, who are eventually going to get shot at and depend for their lives and for the accomplishment of their mission on how well these newly developed weapons perform in the military environment in which they must be used.

Mr. LANIGAN. That is all.

Mr. POLAND. I understand that you advocate unification of the military services?

Mr. SCHENK. Yes, sir.

Mr. POLAND. And that you still believe drastic reorganization may be necessary for a full solution—that you believe that?

Mr. SCHENK. Yes, sir.

Mr. POLAND. And then you say you oppose any drastic reorganization except on an evolutionary basis. Will you please tell us how you will do anything as revolutionary as that on an evolutionary basis?

Mr. SCHENK. Well sir, I think that this is not the time to rock the boat because we are in pretty serious trouble vis-a-vis the competition from the Soviet Union.

Mr. MCCORMACK. Do you not realize it, the time you have drastic action is when there is fear or an emergency situation existing?

Mr. SCHENK. Unfortunately, I am afraid you are right, sir. What we were trying to do 18 months ago was to say that the current structure of the military services was obsolete. We must do something about it. We must gear ourselves to the new age that we are heading into, the atomic thermonuclear age, the space age.

If we could have done it then, and started in an orderly way on a program that was generally accepted, I think we would have been in pretty good shape.

I still think that the final answer is unification. I think, however, that because at the moment we are in very serious trouble and have to work very hard to catch up, we must not do anything that will destroy the current effectiveness of the military services.

Mr. MCCORMACK. You say drastic action for unification—that you are for that—but in view of the situation it should be evolutionary?

Mr. SCHENK. Yes, sir.

I would say: let us make a new plan. Let us suppose that plan is very different from what it is today. Let us set up a target date and everybody concerned, if possible, accept that this is the direction in which we should go.

Then let us establish a time schedule with milestones and with transitional dates, "on the 1st of June 1960 something else will happen." And if it is generally accepted, and not shot down in the process

of being implemented I think we can make this change. This is what we are arguing for.

Mr. McCormack. That is very beautiful from an academic angle. What evolutionary changes would you recommend now?

Mr. Schenk. Regarding evolutionary changes toward achieving true unification of our military services, I consider it important for the record at this point to quote further from the statement of policy adopted August 3, 1956, by the Air Force Association, as follows:

> We must achieve this singleness of purpose, organization, and operation at the earliest possible moment. We must achieve this goal without compromising essential competition of ideas in defense planning and weapons development, while eliminating uncontrolled and wasteful competition for scarce manpower, money, and material.
>
> As the first step, we urge freedom of transfer among the services, geared to the most efficient and economic utilization of our military manpower.
>
> Each of us, civilian and military man alike, must place the realities of national defense requirements above narrow service interest.

The most important one, perhaps, sir, would be the transfer of all officers above the grade of brigadier general—or equivalent—to an Armed Forces of the United States status, with their promotions to that grade being granted them by the Department of Defense rather than by an individual service.

We think this is probably one of the first key steps that should be taken. A lot would follow from that.

Mr. Poland. That multiplies some of the difficulties with respect to those that arise from having a Joint Chiefs of Staff?

Mr. Schenk. I do not understand your question.

Mr. Poland. The Joint Chiefs of Staff is chosen from all of the services, are they not?

Mr. Schenk. Yes.

Mr. Poland. Now if you had the armed services as the upper echelon, would that be the equivalent of perpetuating and continuing the difficulties that come from a Joint Chiefs of Staff?

Mr. Schenk. I think not. I think the opposite would happen. I think the Chairman of the Joint Chiefs of Staff—as he is at present called—should probably become the senior military adviser to the President and to the Secretary of Defense. He, in turn, should have a staff of people reporting directly to him to help give him advice and work out plans and so forth.

If we had this group of senior officers who had primary allegiance to the Department of Defense, rather than to a single service; and had these other things—the chairman of the Joint Chiefs being responsible to the President and having his own staff—then I think the individual military services, as we now know them, could very well, for a period of time, carry out the functions of recruiting, training, providing weapons and manpower to the mission-oriented joint commands that we spoke of earlier. The present armed services would become pools of resources on which the joint commands could draw.

I think that the joint commanders of the mission oriented forces should report directly, in a military sense, to the Chairman of the Joint Chiefs of Staff.

Mr. Poland. Do you not think you are a little optimistic with respect to the quick change of allegiance, once they get by brigadier general?

Mr. SCHENK. I do not believe this will be quick, sir. I believe that the key to it lies in setting it up as an objective, and working it out in an evolutionary way. Certainly, it will not happen overnight.

Mr. MCCORMACK. How long would that evolutionary period take, above the brigadier general and so forth?

Mr. SCHENK. I would say between 5 and 10 years before a complete conversion could be effected.

Mr. MCCORMACK. What would be the next step? As soon as that was completed?

Mr. SCHENK. I would then extend it and make a single promotion list for all officers, at all levels.

Mr. LANIGAN. I just want to be sure that the 5 and 10 years was for the first step?

Mr. SCHENK. No, sir. I think it would take that long for the normal process of promotion to fill up all of the upper ranks—something like 5 to 10 years; in other words, at the end of the 10-year period, all general officers on duty would be members of the new Armed Forces of the United States.

Mr. POLAND. I had a question on a slightly different matter, if you were through with that.

Mr. MCCORMACK. You opened that up. I was just joining you.

Mr. POLAND. I was going to get over to page 9, where you speak of the difficulty in research and development under a cost-plus-fixed-fee basis.

Mr. SCHENK. Yes.

Mr. POLAND. Where you speak of "The rewards for daring are small in comparison with the penalties for failure."

Mr. SCHENK. Yes, sir.

Mr. POLAND. I am wondering, on a cost-plus-fixed-fees basis, if the penalties for failure are not taken into consideration. There is, also, the acquisition of proprietary rights in the underwriting of the research by the Government, where the industry becomes a legatee of that research. Where do you find the penalties for failure?

Mr. SCHENK. Well, sir, one of the penalties that is beginning to worry people a good deal lately is the growing exposure to third-party liability in the dangerous technological areas in which we are working in the nuclear and electronics fields. For example, if the guidance on a missile is faulty, the people who are responsible for the design of that guidance are exposing themselves to liability.

Mr. POLAND. Is that insurable liability or not?

Mr. SCHENK. I am afraid I do not know enough about that aspect of it.

Mr. POLAND. If it is insurable it would be part of the cost?

Mr. SCHENK. A further check reveals that the extent of insurable liability has not been clarified with regard to extrahazardous accidents involving defense industry. It is my understanding that several large lawsuits are now pending in this area; and further, that legislation is before the Congress to help clarify the Government's responsibility regarding extrahazardous accidents involving military equipment, especially those involving atomic explosives.

I believe that is possibly right, sir. I am not an expert in that field, unfortunately. I think another penalty which is not often recognized is the use of the technical resources on the part of industry, or on the part of universities, on different endeavors. The only

real resource from a technical standpoint in the research and development business is critical, because the amount of money involved at this time is relatively minor. The resource I refer to is the pool of technical competence you have control of—the specialists and skilled people in specific fields.

If you bet on the wrong horse, so to speak, you are running the risk that you may be years behind. You may go into a dead-end detour while somebody else who has stayed in the main channel succeeds and grows in the fields that eventually turn out to be most useful.

There are penalties in the sense that technical failure—the news of it—is quickly transmitted throughout the length and breadth of the technical community and the industrial community. Reputations are much harder to keep than they are to destroy.

What really bothers me is that no matter how good a job you do, the reward you get is circumscribed by very narrow bounds. Your profit ratios vary between, say, 6 and 10 percent approximately in research and development contracts; that is the c. p. f. f.-type contract.

Mr. LANIGAN. Can you tell us what you mean by those initials?

Mr. SCHENK. C. p. f. f.—cost plus fixed fee. This is a form of contract that is quite generally used in sponsoring Government research and development. No matter how good a job you do, you cannot ever get over 10 percent. And as a consequence, there is relatively little incentive for the very best people to apply their talents to this type of work, if they can get a much larger reward for working in a different field—except under conditions of war or emergency, when the patriotic incentive governs everything else.

We are talking now about a long pull, about a period covering perhaps decades of cold war, with troubled international situation in which we must maintain our strong military posture. And during such a long pull period, I think it would be most useful if a much broader sliding scale of rewards were established for technical work. This would tend to make the brightest young people, who are now applying themselves to this voluntarily, say to themselves: "Well, if I go into Government research and development, and I do a tremendous job, I can get a much bigger reward quicker than I can by designing new tail fins for automobiles or better refrigerators, or whatever else it might be."

Mr. POLAND. What would you say to the allegation that many of these development contracts and applied engineering contracts get underwritten for their whole basic research and then the development corporation gets a future commercial utility for it, and has had its capital cost contributed by the Government. And further that sometimes by a minor change the firm concerned can get a proprietary interest in the device and reap a large profit?

Mr. SCHENK. I would like to answer that by saying that at the moment I don't see any very good commercial use for spaceships, or intercontinental ballistic missiles, or guidance systems.

Mr. POLAND. I am not at all sure that those are referred to.

Mr. SCHENK. I would say, however, sir, that I think the bulk of the advanced technology required for military purposes is not directly applicable nor immediately applicable to the commercial world. Maybe many years later some of the techniques that came out of mili-

tary research are translated into the commercial world and are useful. There certainly is no doubt that the training of industry's engineers, which takes place because of Government research, is an important thing. Industry can use these trained engineers only to a rather limited extent, actually; but I must admit, they can use them in other work.

I think in general, however, that if a study were made, it probably could be shown that there is not as much of this cross feeding as one might suspect at first glance because of the high degree of specialization of the Government research and development work.

Mr. POLAND. We have heard those allegations made and I judge that you would minimize them as a major factor in the possible profit?

Mr. SCHENK. Yes, I would.

Mr. LANIGAN. What do you propose as an alternative to cost-plus-fixed fee? Are you proposing a competitive bidding on contracts or just what is it that you suggest?

Mr. SCHENK. The very first thing—once again proceeding in an evolutionary manner—would be to open up the sliding scale, the upper scale particularly. Then even though the basic contract forms were retained, if in the judgment of the agency that sponsored the research and development work, an outstanding job had been done which in the long run had saved the Government time and money, I would permit that agency to pay a larger profit for high quality work. Correspondingly, I would put some penalities on the other end of the scale, so that if a very poor job had been done, there would be stiffer enforcement of contract cancellation or perhaps even default clauses of one sort or another. I think this is a matter that should be studied at considerable length by experts. There are many good ideas available on this subject. I have seen studies by trade associations and by individuals who have looked into this particular subject at length.

Mr. LANIGAN. Do you suggest that this is a subject that we should study rather than have any specific solution to it?

Mr. SCHENK. Yes.

Mr. LANIGAN. How about the place of small business in research contracts? It has been said that over 90 percent of the research contracts go to large firms and small business is not getting a fair share. Do you think small business could be definitely utilized in the research effort?

Mr. SCHENK. I think small business has a tremendous contribution to make. I would say that very often small businesses have a unique specialization where they can perhaps be the only expert, or best expert, in a certain field. I think they must be used. They are part of our total economic base that we depend on. There are two major things I have thought about a little that can be done to make small business more useful.

For example, the establishment by Government of a kind of revolving fund. One of the troubles small business has is finances. If they could go to the Government and show that they had an idea or a process that was useful, and had the means to do this work but lacked the funds, they could get a grant or a loan of some sort from the Government which would permit them to apply their talents and pursue this line of endeavor.

Another thing is that larger industries which have contracts for bigger systems jobs should be encouraged—although they are, indeed, doing a tremendous amount of subcontracting—to act as agents to

split up the total job into smaller packages. These smaller packages would be digestible by small business, and geared to the particular fields of specialization which small business could handle.

Mr. POLAND. Do you think that small business is being utilized for research work to the maximum extent that is feasible at the present day?

Mr. SCHENK. I would like to say both "yes" and "no," and elaborate for a moment.

In general, small business cannot afford the degree of emphasis on research as large corporations which have their own research laboratories and so forth. Thus there is a smaller reservoir of technical potential in small business than one would suspect upon first glance. The principal orientation of small business is toward manufacturing and service. They are often very good in making specialized parts which fit into larger equipment, which in turn fits into a system.

There are, however, many good ideas hidden away in small business. I think our biggest problem is to find out where these good ideas are. We need a mechanism to get at them, to pull them out and support them. Therefore, I would add to my earlier suggestion about a revolving fund, a proposal for some kind of a communication or information mechanism which would permit small business to report what good ideas they have and, at the same time, would permit someone capable of utilizing the ideas to look at them and to make a decision and support them if they were good. We are not getting enough of that done now. However, at the moment I don't have a well thought out idea on how it can be followed through.

Mr. POLAND. Those are the only questions I had on small business.

I was thinking of one more, Mr. Chairman, in respect to whether you entertained an opinion as to the desirability of negotiating contracts as against open competitive bidding? It has been said where there is open competitive bidding many firms come in which are not fully qualified and that those who are in the know could make a selection of half a dozen of the outstanding firms and arrive at a negotiated conclusion at a considerable saving over the competitive process.

Do you care to comment on that?

Mr. SCHENK. In general, I would agree with the statement you have just made, sir.

Mr. POLAND. Excuse me. I did not think I was making a statement. I was raising the question. I do not know which side to agree with.

Mr. SCHENK. I am a great believer in competition, that is, free enterprise, as I said earlier. I think there are times when it is in the interest not only of the Government and the taxpayers, but of the potential contractors themselves, if a degree of selection is exercised first and the final contract award made by a process of negotiation with preselected bidders.

Let me offer an example. I have a very good personal friend who started a small business after the war. He mortgaged his house, borrowed on his life insurance, went into business and submitted quotations on wide open competitive bidding to Government agencies. Several tmes his quotations, because of inexperience, were too low. He didn't have the facilities he thought he had, and he failed in carrying out these contracts. He was very seriously embarrassed and had some pretty rough times for a few years.

If the philosophy of preselection and negotiation had been employed in those instances and he had gone to an experienced Government contracting officer, who would have said to him: "Now, look here, son, I don't think you are really capable of doing this; you don't have the resources and you don't realize what you are getting into," I think he might have backed away.

Mr. McCormack. That Government official would get into trouble. That is the other side of it.

Mr. Schenk. Under the present rules.

Mr. McCormack. No. I think any Government official that undertook to tell anyone, "You have not got the experience," and so forth, in the case, might get in trouble himself. We are dealing with human nature in all of these things.

Mr. Schenk. Yes.

Mr. McCormack. We must realize that. We cannot get away from the influences of human nature. We have got to keep that always in mind.

Mr. Schenk. All right, let me modify that. Rather than to have this said to the potential contractor, let's suppose a Government agent, in the privacy of his office, had reviewed those bids and perhaps consulted with other experts in the Government. And suppose he had said, "Now clearly, this young fellow isn't qualified. Let's throw him out of the competition." I think in the final analysis it would have done both the potential contractor and the Government a favor.

So I am for negotiated bids under such circumstances rather than complete competition in which the Government always must accept the lowest bid.

Mr. McCormack. I do not think you wanted to get yourself in trouble.

Mr. Schenk. I am talking about the field in which I am competent, that of research and development, which is a highly specialized and technical field.

Mr. McCormack. On cost-plus-fixed-fee, is there not a selection beforehand of 2 or 3 or 5 or 6 companies and then they submit a bid on the cost-plus?

Mr. Schenk. Yes, sir.

Mr. McCormack. Ordinarily, I would not say generally, but to some extent even after that, is there not some negotiation?

Mr. Schenk. Yes.

Mr. McCormack. So even cost-plus-fixed-fee sometimes involves negotiation afterward when they get their offer of the cost plus and the fixed fee, and so forth—sometimes they say, "So and so bid so and so; can you go lower?"

That is probably not in that language, but a little more dynamic. There might be a mixture of cost-plus-fixed-fee and negotiated involved in that.

Mr. Schenk. Yes, indeed. I do not think they are mutually exclusive at all.

Mr. McCormack. Of course, we know there are different categories but they are put into interlock one with the other.

Mr. Schenk. What I would really like to say, sir, is that I am not involved in the business aspects of research and development. I think this is a field which needs more study. It needs a close look, by a committee such as this, at the procedures and the policies which are

now being followed. I have a feeling that something important can be done to improve the way in which the technical talent of the country—whether in universities or in industry, in small business or in large corporations—is applied to these problems. It could be done better.

I think we must somehow set up more incentives and more stimulation. We must make it worthwhile for young men, who are at the beginning of their careers, to want to go into this kind of work rather than something else—not only to serve their country, which we all want to do, but in addition, to provide better for their families and for their children, and enjoy the fruits of their labors.

Mr. McCormack. Any further questions?

Mr. Lanigan. I have some.

I take it then that you believe that basic research has to be stimulated and supported through Government action, that it cannot be left just, say, in the hands of industry to take care of the basic research that this country needs?

Mr. Schenk. Yes, sir, I believe that is right.

Mr. McCormack. Where will that lead us to if the Government dominates in the field of basic research?

Mr. Schenk. I don't believe support is necessarily synonymous with dominating. I think the Government should suport and stimulate basic research but by no means dominate it.

Mr. McCormack. All right.

Mr. Lanigan. On page 3 you speak of "studies analyzing the life cycle" of major military items, which shows that as much as 50 percent of the total life cycle was consumed in nonproductive decision dead time.

Could you identify the study or studies to which you refer?

Mr. Schenk. Yes, sir. I would like to refer you to a gentleman who is, to my knowledge, probably the best expert in this field. He led the investigations I referred to over a period of many months. He is James N. Davis; at that time he was in the office of the Secretary of Defense. He later worked on the staff of Mr. Curtis, who was then the Special Assistant to the President for Aviation. I believe Mr. Davis now is in private industry. I will find out for you exactly where he is and how he can be reached.

Mr. Davis was in charge of a series of investigations which took into consideration several different representative types of equipment—some in the electronic, some in the aeronautical field. Detailed studies were made of the histories of these items, from issuance of the very first directive, that such a thing should be developed until it was finally tested and produced.

I remember looking at some of the flow charts and graphs of the time period involved, and in some instances as high as 50 percent of the time was shown as nonproductive technical time, because things were stopped for decision or consultation. I have not seen those charts now for some time. So I cannot give you the specifics myself, but I am sure that Mr. Davis could do so.

Mr. Lanigan. On the same page you speak of overspecification as one of the reasons for sluggishness in the decision-making process. Could you give us some example, some detail of what you mean by that?

Mr. SCHENK. Yes, sir. I would like to elaborate a little on what I mean. Today in the research and development of end items of equipment, or of weapon systems, we very often find that the sponsoring agency writes rather detailed specifications as to size, weight, shape—if it is electronic, frequency of operation, for example—and many other characteristics, all of which relate to a particular requirement for a military purpose. Rather often the achievement of the end purpose, in the way it is stated, is inconsistent with the other detailed specifications that have been stated first.

In other words, you just cannot make it do this or that and still be this small. Or, you cannot make it do this and that and still only use 10 vacuum tubes. You will really have to use 15, it turns out, when you analyze it.

So it seems to me that we should either tell somebody what to do and specify the end result, or we should tell somebody how to do it and be satisfied with the end result. But you cannot do both.

Mr. LANIGAN. Are you speaking now from your personal experience in research work?

Mr. SCHENK. Yes, sir, I am.

Mr. LANIGAN. And you are employed in research at the present time?

Mr. SCHENK. I am in research in technical planning at the present time. I am not actually doing the research with a soldering iron in my hand. I am with the technical military planning operation of the General Electric Co. We are concerned with weapon-systems planning.

Mr. MCCORMACK. Can you give some evidence—I like to hear evidence—actual evidence I like to hear—can you give us that in support of these statements?

Mr. SCHENK. If I may, sir, what I would like to do is to go back and review my files and submit some specific case histories.

Mr. MCCORMACK. I think that you can do that when you receive the transcript. You will be permitted to edit your testimony. You can do it when you edit it and you may enlarge on the answers in looking them over. You are talking extemporaneously in answering the questions, and you may express yourself in a manner that you would like to alter or amend. And you will have that opportunity to do so, so long as you do not change your answer, to change the context of any colloquy that might be had. That would not be in relation to any answers. We are just receiving your views for later consideration by the subcommittee.

Mr. SCHENK. As stated, my reference to overspecification was in reference to the attempt to spell out in too much detail how development work should be performed rather than to define the end result desired.

Under this definition, the desired objective would be to provide industry with performance-type specifications, based on the military requirement, and give industry maximum latitude on how to create the materials to meet such specifications; and, at the same time, establish a fair system of rewards and penalties for surpassing or failing to meet established goals. The concentration of Government would be on end results rather than the means to an end.

However, this objective cannot be attained under existing Armed Forces procurement regulations, which stem from statutory author-

ity. The current practice is for the Government to establish detailed contractual procedures and safeguards which, in turn, lead to detailed work statements regarding the how rather than the what of the matter at hand. Under existing regulations the Government is forced to negotiate cost-plus-fixed-fee, or other cost-type contracts, and provide project administrators responsible for seeing that the Government gets its money's worth. For protection, and understandably so, these project administrators, using Government analyses, tend to specify exacting technical details desired for results.

Adding it up, industry finds itself caught in a maze of general specifications covering in precise terms the technical features of a weapon or weapons system. For example, the general specifications covering the preparation of just one category—engineering drawings—for the Navy and Air Force, fill up 716 pages of printed matter. And that's for engineering drawings alone.

When a contractor finds it impossible to fulfill the prescribed specifications or finds a more advanced technique than has been prescribed (as happens so often in this time of rapid technological development), the contractor is required to submit a deviation request for approval before he can make a change from the original specification. When the contractor cannot fulfill a specification, or the procuring service desires a technical change from its original specification, the contractor is allowed or directed to modify his design. To do so, he becomes enmeshed in another maze of documents. These are called engineering change proposals. Thousands of these engineering change proposals are processed by the military services each month. To process an important engineering change proposal, and obtain engineering approval and contractual coverage for it, consumes several months time. And these days, time is a precious asset.

Mr. McCormack. Following Mr. Lanigan's, your second observation, I can understand overspecification, and I do not think you say that means that is a simple proposition by any means.

Mr. Schenk. It is a contributing——

Mr. McCormack. It could be disturbing—it might be that the Government officials follow certain law. Maybe there should be flexibility, and you are testifying now about cost-plus-fee contracts that are given to private companies or in a contractual relationship with the universities, and so forth; is that right?

Mr. Schenk. Yes.

Mr. McCormack. Those are employees not of Government but of the companies, for example, that the cost-plus-fixed-fee contract is made with?

Mr. Schenk. Yes.

Mr. McCormack. So in relation to fees and so forth, a lot of that is on the company level, is it not?

Mr. Schenk. Probably it is; yes, sir.

Mr. McCormack. Of course, when you get to that, you get too high, and then there is a rating and all of that. That is another subject.

But you say the diffusion of authority—to me, that is a major proposition. "In that too many different offices or individuals must be consulted for necessary approval to proceed with a project."

What is your evidence on that?

Mr. SCHENK. Once again, I think I could give you specific case histories of programs and projects that are undertaken, and of what approvals are necessary at which different places.

Mr. MCCORMACK. That is diffusion of authority on what level?

Mr. SCHENK. I believe it is at almost all levels, sir, from the point of view of the individual project engineer who has to get approval of drawings and approval of necessary components, on up to the very highest levels in large systems.

Take a weapon system like, say, the Snark guided missile.

Mr. MCCORMACK. By the way, is the Snark an effective weapon? I would just like to ask your opinion, if you have it, if you are capable of giving it. I don't want you to give any opinion unless you feel qualified.

Mr. SCHENK. I have had some exposure to the Snark in a second-hand way. I think in its present form of development it is an effective weapon. Obviously, it doesn't have the high performance that ballistics missiles will eventually have.

Mr. MCCORMACK. How fast does it travel?

Mr. SCHENK. It is subsonic. It flies at about the speed of some of our newest airplanes, but slower than sound.

Mr. MCCORMACK. About 700 miles an hour?

Mr. SCHENK. That is right.

Mr. MCCORMACK. How fast can a ballistics missile fly?

Mr. SCHENK. Oh, 10,000 miles an hour. There is no comparison. Outside of that, the Snark is a small——

Mr. MCCORMACK. Well, I won't get into that. You go ahead.

Mr. SCHENK. The problem of diffused authority is quite general. It exists at all levels, up and down, if you are looking at it from the point of view of the individual project engineer who has to get numerous approvals of drawings, and so on.

Mr. MCCORMACK. What about the Government level?

Mr. SCHENK. I am talking about the Government level.

If a project engineer, whether in industry or Government, wants to proceed, he has to get approvals from other people in the Government, if that is what you mean by "Government level."

Now, on a higher scale, if a contractor is engaged in a program on Government contract, he has to get all kinds of approvals from different parts of the Government at various stages before he can even start.

What I would prefer to do, sir, if I may, is to give you some really explicit case histories on this.

Mr. MCCORMACK. All right.

Mr. SCHENK. The big problem is that a great many people can say "No," and that stops it. But they all have to say "Yes," together. It is like putting a key into a Yale lock. All the tumblers have to line up before you can turn the key. There isn't a single person to whom you can address a thing, and say, "Will you buy it?"

Mr. MCCORMACK. Of course, the key in a human mind—you don't have a fixed thing. The human mind is a very flexible thing, on a key.

Mr. LANIGAN. You will give some case histories to illustrate this point?

Mr. SCHENK. Yes, sir.

Mr. POLAND. Both points, Mr. Lanigan.

Mr. LANIGAN. Yes; both points.

Mr. McCormack. I thought there were three points. You can review this. We are not cross-examining you like in a courtroom, as if you were a witness on the other side. We are trying to get information from you.

DIFFUSION OF AUTHORITY

Mr. Schenk. Regarding diffusion of authority, we believe, as stated, that in the Military Establishment too many different offices or individuals must be consulted for necessary approval to proceed with a project.

In explanation, I refer to evidence gathered by Hanson W. Baldwin, military editor of the New York Times, in a survey of this problem. Mr. Baldwin found a total of 30 civilian Secretaries, Assistant Secretaries, or their equivalent in the Pentagon who, as he put it, "can give directives to the military chiefs of the services, even though most of these civilians have no legal responsibility."

Mr. Baldwin related the problem as it concerns the Chiefs of the services, specifically Admiral Burke of the Navy and General Taylor of the Army, as follows (in the New York Times of February 6, 1958):

> Admiral Burke keeps on a table in his Pentagon office a long list of miniature flags, each the standard of one of the powerful but little-known civilians who stands between him and the President of the United States. There are 11 in the Defense Department and 6 in the Navy.
>
> Gen. Maxwell D. Taylor, Army Chief of Staff, pointed to the same problem in an address last September:
>
> "There are 19 civilian officials between the Army Chief of Staff and the Commander in Chief, who either command, control, or influence his (the Chief of Staff's) conduct of the business of the Army."

I have referred to the number of people in the Pentagon who can say "No," the few who can say "Yes," on a project. Mr. Baldwin, referring to the problems confronting Admiral Burke and General Taylor, added this:

> Each of these principal civilians has deputies and numerous assistants, most of whom have the power to negate or delay, few of them have the power to approve or expedite.
>
> Nearly every proposed defense project impinges upon several, or all, of the special fields of the numerous Assistant Secretaries of Defense, so that all kinds of cross-checking and "coordination" is necessary. The result sometimes, in the words of one authority, is like "punching a feather pillow"; you can get no solid result.
>
> There have been many instances of delays of many months in action on requests for urgent research projects, some of them involving only small sums.
>
> An official writes about the Navy:
>
> "There are decisions being made as to what missiles will go into certain programed new construction men-of-war. And who is making the decision? The Chief of the Bureau of Ordnance or the Chief of Naval Operations? Not at all. The Controller. Not on the basis of military effectiveness but for budgetary reasons."

Mr. Baldwin is a veteran military reporter, one of the best known in the country. I believe, in this instance, he has made an important contribution to our understanding of the "diffusion of authority" problem.

Mr. Trevor Gardner, former Assistant Secretary of the Air Force for Research and Development, has summed up the matter with the remark:

The technological changes are coming faster than our current decision-making machinery in Government is able to work, and this something has to be done about.

In his statement to the Subcommittee of the Air Force of the Committee on Armed Services, United States Senate, of June 14, 1956, Mr. Gardner further explained the problem in these terms ("Study of Airpower," p. 119):

One of the standard devices for establishing a coordination between the services is a coordinating committee. Such committees exist in each of the technical areas.

Then there is coordination that has to be worked out between the military management and the civilian management and between the various Assistant Secretaries of Defense and the various Assistant Secretaries of the three services.

There are numerous devices for this. In general, the pattern is when you have a really difficult decision to make, you send it out to be restudied, and then having restudied it, it is discussed for a reasonably long period of time, after which by now the technology has advanced so that you have to go back and restudy the whole thing over again.

This is a pretty standard pattern throughout the Defense Department. I think it existed before the current management arrived, in many areas, and it has tended to increase during the past 3 years.

Mr. McCormack. Do you have a question, Mrs. Harden?

Mrs. Harden. Yes, Mr. Chairman.

On page 2, fourth paragraph, the last sentence:

We must have a single military service, with 1 Secretariat, 1 Chief of Staff, 1 promotion list.

Then, over on page 5, the last paragraph:

The Air Force already has left 90 percent of the atmosphere below it in current operations, leaving only 10 percent to be conquered for flights in space—

And continuing.

Does this suggest that the Air Force should ultimately be the single service?

Mr. Schenk. No.

The Air Force, as we now know it, would disappear if we had a single service. It would be absorbed into it.

Mrs. Harden. Thank you. That is all, Mr. Chairman.

Mr. McCormack. Are there any further questions?

Mr. Henderson. I would like to ask a question.

Mr. McCormack. Mr. Henderson.

Mr. Henderson. When you are getting your case histories, I wonder if you would mind giving us some examples of the budget policy that has been pursued in the Department of Defense, which you referred to at the bottom of page 4.

We are particularly interested in that.

(Subsequently Mr. Schenk submitted the following statement:)

In the past few years, it has become standard practice for the Office, Secretary of Defense, to publish research and development guidelines and distribute them to the individual services prior to the preparation of a new budget estimate. For further details on this procedure and its ramifications, I call attention to the statements of Mr. Trevor Gardner, former Assistant Secretary of the Air Force for Research and Development, before the Subcommittee on the Air Force of the Committee on Armed Services, United States Senate, on June 14, 1956. Specifically I refer to that portion of Mr. Gardner's testimony appearing on

pages 1106 and 1107 of the document, Study of Airpower, covering the hearings of that subcommittee. The pertinent testimony is as follows:

"Mr. HAMILTON. Now, with reference to your mention of money, are you familiar with the guidelines that are established with respect to funds for research and development in the Defense Department?

"Mr. GARDNER. Yes; I am.

"Mr. HAMILTON. I wonder if you would describe briefly the nature of those guidelines and the amounts of money involved, as you recall them, during the period that you were concerned with those problems.

"Mr. GARDNER. Well, each year the guidelines have been different, but each year they have always been a dictated figure by the Secretary of Defense's Office.

"Mr. HAMILTON. Now I wonder if you would just describe briefly what a guideline is.

"Mr. GARDNER. It is a blank instruction which the Secretary of Defense gives to each of the three services so that they might put some general dimensions on their program.

"Mr. HAMILTON. Is that before they have formulated a program for the year to which the guideline relates?

"Mr. GARDNER. It is reasonably independent of the formulation of the program and it is a flat ceiling which none of us has been able to break so far.

"Mr. HAMILTON. A flat ceiling in terms of what; in terms of dollars?

"Mr. GARDNER. In terms of dollars; correct.

"Mr. HAMILTON. It does not go into particular projects, I take it?

"Mr. GARDNER. Not always; no.

"Mr. HAMILTON. And, in general, do you recall what the order of magnitude has been for those ceilings for any particular year?

"Mr. GARDNER. Yes. In general, the amount of money that has been made available to us has been in the order of $400 million, but tending to decrease each year.

"Mr. HAMILTON. Tending to decrease each year?

"Mr. GARDNER. If I could elaborate on that point.

"Mr. HAMILTON. Yes.

"Mr. GARDNER. Not only decreasing in amount but, as you know, during the past 3 years, prices have gone up in just the buying of skills and services and hardware. Additionally, all the things we are trying to do are not just twice as hard as what we were trying to do before.

"For example, flying at twice the speed of sound is not just twice as hard as flying at the speed of sound, and when I say hard, I mean expensive, so that we not only are having our budget monetarily reduced in research and development but the budget did not go as far because we had to do more expensive things with it, and this caused us an undue concentration on a few projects, and a lot of projects which we let remain in the study stage to save money.

"Mr. HAMILTON. During what period of years are you talking about, Mr. Gardner?

"Mr. GARDNER. My familiarity with this thing dates back to February of 1953. I am talking about the years 1953, 1954, and 1955, and until I left the Air Force in February.

"Mr. HAMILTON. February of this year?

"Mr. GARDNER. Yes.

"Mr. HAMILTON. You are talking about the period 1953 through February of 1956; is that right?

"Mr. GARDNER. Correct.

"Mr. HAMILTON. And it is your recollection that the amount of funds that were made available on the guidelines tended to diminish somewhat?

"Mr. GARDNER. Yes. Could I expand on this point just a little bit?

"It is a little involved because, along with the ceiling that is given, usually one is told to withhold a certain amount of money and not spend it during that year; so this tends to reduce the amount.

"Mr. HAMILTON. What is the purpose of that?

"Mr. GARDNER. The purpose of it is so that you don't run out of money, and there is always a question of how much should be withheld.

"Mr. HAMILTON. As a cushion, so to speak, for a reserve?

"Mr. GARDNER. That is correct.

"Then there is another kind of control placed on this money. In 1 year, 20 percent of it was held back until almost the whole year had gone by, and then it was made available to us when we could no longer spend it.

"Mr. HAMILTON. What was the reason assigned for that procedure?

"Mr. GARDNER. One of the civilian managers in the Secretary of Defense's Office explained it to me in this way, that that was the only way to find out how much water there was in the program."

That testimony, as stated, covered the period of 1953 through February of 1956. I believe the committee will find, upon investigation, that specific dollar ceilings were established for the Army, Navy, and Air Force research and development programs for the fiscal years 1957 and 1958 prior to any review of requirements by the Office, Secretary of Defense.

It is my understanding that the research and development guidelines of the Defense Department for the fiscal year 1959 did not establish new obligating authority ceilings for research and development for the three services. However, I believe it also true that these same guidelines did establish for the services the priorities desired by the Office, Secretary of Defense, and the areas where fund requirements were to be held to a minimum. Further, I believe the services were given to understand that stated expenditure limits would be imposed on research and development work in the fiscal year 1959. Thus, the end result is about the same as actual ceilings established for the previous years.

Mr. HENDERSON. You say the Secretary of Defense has departed—the Office of the Secretary of Defense—from its policymaking mission to become deeply engaged in military operations.

We have been under the assumption that the Secretary of Defense is not limited in that way at all; that he was involved in military operations, as well as other matters. I was wondering if that statement formed an assumption that underlies other aspects of your testimony here.

Mr. SCHENK. I believe I should elaborate a little on this.

They key word here is "operations," as distinguished from "policy." As I recall it, the Office of the Secretary of Defense was originally established in 1947 by law, and originally consisted of about 100 people. Now it is up to, oh, perhaps 2,000. I don't know the exact figures.

But instead of the original intent of letting this be a policymaking group to coordinate the activities of the separate services through policy statements, it has become involved in all kinds of operating routines, day-to-day processing of papers, and so forth.

This was the distinction I was trying to make in that sentence.

Mr. HENDERSON. The only thing I question is whether the original intention was that the Secretary of Defense would be limited to that policymaking role.

Mr. SCHENK. That is a very interesting question.

I had assumed that myself, but I don't really know the answer, for sure.

(Subsequently Mr. Schenck submitted the following statement:)

The National Security Act of 1947 (sec. 202 of title 2) spells out the duties of the Secretary of Defense as follows:

"1. Establish general policies and programs for the National Military Establishment and for all of the departments and agencies therein;

"2. Exercise general direction, authority, and control over such departments and agencies;

"3. Take appropriate steps to eliminate unnecessary duplication or overlapping in the fields of procurement, supply, transportation, storage, health, and research;

"4. Supervise and coordinate the preparation of the budget estimates of the departments and agencies comprising the NME; formulate and determine the budget estimates for submittal to the Bureau of the Budget; and supervise the budget programs of such departments and agencies under the applicable appropriation Act * * *."

I believe it is clear from a study of the act that policymaking and programing is the primary duty of the Secretary of Defense. Study of the original concept of the Office, Secretary of Defense, as that concept emerges from the

unification hearings of 1945, seems to be that he would concentrate on major policy issues and grand strategy, on such top-level subjects as force structure, roles and missions, etc. In this context, the Secretary of Defense would depend on the individual services for operations and administration, while he dealt with high level military matters. In fact, the National Security Act of 1947 specifically provided "that the Department of the Army, the Department of the Navy, and the Department of the Air Force shall be administered as individual executive departments by their respective Secretaries and all powers and duties relating to such departments not specifically conferred upon the Secretary of Defense by this Act shall be retained by each of their respective Secretaries." The Forrestal diary indicates that Mr. Forrestal, the first Secretary of Defense, conceived the job in these terms, and so pursued it. Succeeding Secretaries of Defense continued to function in the primary role of policymakers.

When Mr. Wilson became Secretary of Defense it became quite clear that he conceived of his job in terms of business management of the Armed Forces, with emphasis on the role of comptroller rather than policymaker. Hence, while Mr. Forrestal conceived of his office as a small, well-integrated organization with a few Assistant Secretaries and total personnel well under the 1,000 mark, Mr. Wilson conceived of it an organization of managers with 10 or more Assistant Secretaries of Defense and several thousand personnel.

The net result has been, as I have stated, an office engaged in day-to-day operations of various sorts. Again, the tendency has become to tell the services not only what results are expected of them but how these results are to be achieved.

The "how to do it" philosophy has spread from directives on multibillion dollar weapons systems to how to walk in the corridors of the Pentagon—actually the subject of a Defense Department instruction full of helpful hints such as advising the use of rubber heels, etc.

Perhaps the classic example was that given public view by the Navy League of the United States in its November-December 1955 issue of the publication Now Hear This. This concerned Department of Defense Instruction No. 4151.8 dated October 20, 1955. The subject: Refuse Collection and Disposal. As written, the purpose of the instruction was "to establish standards for efficient and economical refuse collection and disposal systems consistent with good sanitary engineering principles," and applied to "collection and disposal of garbage, trash, ashes, and debris." The instruction proceeded to outline in some detail Defense Department standards regarding frequency of collection, disposal, can washing, collection and disposal systems, equipment and contractual services. It was signed by the Assistant Secretary of Defense for properties and installations. In comment, the Navy League made it clear that the instruction was not an isolated case but rather typical of the Department's new role in our military affairs. A similar instruction, I understand, covered grasscutting standards for the military down to the precise height of grass desired under various circumstances.

Mr. HENDERSON. Thank you.

Mr. POLAND. One thing in respect to overspecification.

We have instances which seem to be underspecification. When we studied fuel booster pumps, while recognizing that there are size and capacity differences, we found there were some 500 different types performing about the same job. Some of the differences were limited to those between a round and a hexagonal base, and whether they had 12- or 15-bolt holes in them.

When you submit your case histories, will you help us a little as to the problem of underspecification as well as overspecification?

Mr. SCHENK. All right, sir.

I hope my attack on overspecification will not be confused with the need for standardization. You have to standardize, or things won't fit together. If you can standardize on fewer things for the same essentials, things will work out.

Mr. MCCORMACK. Do you have any other questions?

Mr. LANIGAN. I have one or two more.

Mr. MCCORMACK. All right; make it quick.

Mr. LANIGAN. On page 7, Mr. Schenk, you mentioned the present practice of splitting up research and development budgets in tight little compartments. Could you explain that?

Mr. SCHENK. Yes, sir.

Again, this may have changed in the last few years. But my recollection of this, when I was involved in the business, is that a project engineer who wanted to accomplish an objective had to go to one office to get travel money, to another office to get his telephone and administrative budget, somewhere else to justify the buying of laboratory equipment to test his work, to another place to get authorization for supporting contracts he might want to place somewhere. Making this all come out even is an extraordinarily tough problem.

The agency that he is a part of might run out of travel funds, so all of a sudden he can't travel any more. This means he can't intelligently supervise his supporting contracts.

What I advocate is a system of budgeting where you can spend project funds for any reasonable purpose that has to do with achieving your technical objective, not to be limited by a number of other somewhat arbitrary things that have nothing really to do with what you are trying to accomplish.

Mr. LANIGAN. Does the Air Force Association have any views on the adequacy of research and development projects and research and development programs in the military service?

Mr. SCHENK. I believe, sir, and the association believes, that they are not now adequate, and have not been adequate.

Mr. LANIGAN. Do you have any recommendations as to what an adequate level in comparison with the present level would be?

Mr. SCHENK. I would hate to give you an off-the-cuff answer. I would say it is probably several times as high as it is today.

Mr. MCCORMACK. You mean, on basic research, or on all research?

Mr. SCHENK. All research; with particular emphasis at the moment on basic research. I think it is inadequate across the board.

Mr. MCCORMACK. What are we appropriating now for all research in various agencies?

Mr. STRAUBEL. I have figures here from the new budget, sir. It is by service.

The Army, $471 million—this is obligational availability, total research and development; $641 million for the Navy; $719 million for the Air Force; and $425 million for the Office of the Secretary of Defense.

It is quite interesting that these somehow average out to 5 percent of the total for the Army; 6 percent for the Navy; 4 percent for the Air Force; and 37 percent for the Office of the Secretary of Defense, of the total budget.

Mr. MCCORMACK. There are other appropriations for other agencies?

Mr. SCHENK. Yes.

Mr. STRAUBEL. This is just for the military agencies.

Mr. MCCORMACK. My question is if the appropriations probably are in excess of $5 billion, considering all of the Federal agencies and departments.

Mr. STRAUBEL. A very small gain, sir, over 1958, when it was appropriated without the——

Mr. McCormack. I am not arguing against an increase. But I am talking about the several items, I was wondering if you would consider the matter, and you can express your views upon reflection, when you answer it. That is a hard question, I know. I wouldn't want to have it shot at me if I were in your position.

Mr. Schenk. My big trouble is I don't know what is in the other categories.

(Mr. Schenk subsequently submitted the following:)

Regarding our opinion on an adequate funding level for military research and development today, the answer is complicated by the recently established Advanced Research Projects Agency within the Office, Secretary of Defense, to handle the research and development of advanced weapon systems. As a result, it is not entirely clear at this moment what the position of the individual services will be in this area of research and development. For example, it is my understanding that more than 50 percent of the Air Force research and development program, as included in the fiscal year 1959 budget, was designated for projects in astronautics. If the new superagency is to take over the bulk of astronautics research and development, as has been reported, it is not clear what the future holds for space flight research and development by the single services.

However, I reiterate my statement that the budget for the next fiscal year, and for an indefinite number of years ahead, should be several times as high as the present level—at least as it pertains to basic research. I believe we are spending far too little in this area, which is the foundation for our future security.

Further, I am quite sure, based on past experience, that the program projected in the fiscal year 1959 budget for military research and development is less, by several millions of dollars, than the amounts considered by the services as a minimum requirement. Again based on past experience, I feel that additional funds, in sizable amounts, could profitably be utilized for Air Force research and development.

In explanation: When one compares the fiscal year 1959 budget estimate with the fiscal year 1958 budget for military research and development, and adjusts the 1959 figure for cost-of-living increases, there is essentially no difference in the dollar quantity of the two programs. Yet, the requirement for increasing the tempo of our total military research and development effort is by now generally recognized; and concentration of the security threat in space weapons, and other areas of the Air Force mission, is also quite apparent.

Mr. McCormack. Are you going to testify, Mr. Straubel?

Mr. Straubel. No, sir.

Mr. McCormack. Are there no further questions?

(No response.)

Mr. McCormack. Thank you very much, Mr. Schenk. We appreciate your appearing before us.

If there are no further witnesses, the subcommittee stands adjourned, subject to the call of the Chair.

(Whereupon, at 11:30 a. m., the subcommittee adjourned, subject to the call of the Chair.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

TUESDAY, JANUARY 28, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND LEGISLATIVE REORGANIZATION OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1501, New House Office Building, Hon. John W. McCormack presiding.

Present: Representatives McCormack (presiding), Fascell, Harden, Brown, and Meader.

Also present: Orville S. Poland, general counsel to the committee, James Lanigan, associate general counsel; William A. Young, staff consultant, and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK. The subcommittee will come to order.

We are very happy to have testifying this morning L. V. Berkner, president of Associated Universities, Inc. Doctor, we will be glad to hear from you.

STATEMENT OF L. V. BERKNER, PRESIDENT, ASSOCIATED UNIVERSITIES, INC.

By the way, Mr. Brown, did you want to ask a question?

Mr. BROWN. Yes, Mr. Chairman. I am forced to leave in just a few moments to go to the Rules Committee where we will have an important bill before us that has to be brought to the floor quickly, as you well know, as a majority leader.

I read with a great deal of interest, Doctor, the statement you will make. I want to compliment you on it. I think it is a very sound and able statement and is a real contribution to those of us in the Congress who are wrestling with the problem before us as to what to do about getting more scientists and more mathematicians, and as to how we can better our educational system.

I would like to ask you a question or two, if I may. You say here in your statement:

> When high schools do not offer sufficient training in science and mathematics, the student loses his choice to elect science and mathematics as a career.

Do you feel, from your knowledge and experience, that the high schools of the country, which are controlled by the States and local communities, are teaching science and mathematics in sufficient amount and quality?

Dr. BERKNER. Only certain high schools, Mr. Brown. It is quite clear that there are a large number of high schools, perhaps largely due to teacher shortage, who are not offering the courses in mathematics and sciences that are necessary to provide for matriculation of students from those high schools into the university if they elect to go into the field of science or mathematics.

Mr. BROWN. What proportion of our high-school students take science and mathematics now?

Dr. BERKNER. In the field of physics, for example, the proportion of students taking physics has fallen from 80 percent in about 1880, to about 5 percent at the present time. This, of course, is a very large drop.

Mr. BROWN. Do you feel that one of the reasons for this large drop is that we permit the students, of their own volition and judgment, to decide what elective courses they will take?

Dr. BERKNER. This is certainly part of the problem, but not all of the problem, because in many high schools, because of the lack of teachers, even if the student elected to take those subjects they would not be taught.

Mr. BROWN. I watched a television program—nationwide—here a Sunday or two ago in which they interviewed students from what was supposed to be the model high school of the country. All of the boys who were interviewed, with one exception, said they were taking coeducational cooking, which, of course, may be very important if you are going to be a milquetoast in afterlife. But these boys frankly stated to the newsreel reporter they were taking the course because it was easy, and one boy even said, "Well, it is coeducational; it is party time and we get to pitch a little woo in there." I am just wondering, as an educator, what is your opinion of that sort of a situation?

Dr. BERKNER. In my opinion, much too much leeway is given to the youngster in elective courses in the high school. At the age of 11 or 12, on entrance to high school, most youngsters are not yet in possession of information to make the judgment as to where they would like their future to lie.

One of the purposes of the high school is to provide them with the knowledge and training which permits them to exercise that judgment when they leave the high school. If electives are provided in the high school to too large an extent, then quite clearly the youngster never acquires the information to make good judgment with respect to his own career.

Mr. BROWN. Is your understanding the same as mine, that the real purpose of an elementary school or high school, is to give a boy or girl a basic education upon which he or she can set future education, occupation, or profession?

Dr. BERKNER. Yes, sir.

Mr. BROWN. Now you said 5 percent, if I remember correctly, are taking physics. What percent are taking mathematics, including algebra?

Dr. BERKNER. I am afraid I couldn't give you that number offhand.

Mr. BROWN. Do you have any idea?

Dr. BERKNER. I would suppose that it would be somewhat higher because many youngsters will take the elements of the subject. However, I should point out that, for example, Dean William Everett of

the University of Illinois, head of the Department of Engineering, has found it necessary to give special examinations to youngsters entering the engineering school of the University of Illinois and to provide that most of them undertake an additional training period before they enter the university. This is to build up their science and mathematics to the point where they can matriculate and compete.

Mr. BROWN. If I recall correctly, some rather authoritative sources have told me that less than 25 percent of the students in the high schools of the United States take mathematics, such as algebra and geometry. I have had the experience, Doctor, and I am sure most Members of Congress have, that in connection with service academy entrance examinations of having boy after boy tell us he can't participate because he has never had any mathematics in high school.

Dr. BERKNER. That is true.

Mr. BROWN. Now, do you think we can make scientists and mathematicians and chemists and technicians out of boys who have never had any mathematics, not much arithmetic, and no algebra or geometry?

Dr. BERKNER. Well, it is possible, if they have the will to do the studying afterward.

Mr. BROWN. You mean to learn mathematics afterward?

Dr. BERKNER. Yes; but the difficulty is if they don't get it in high school, it is very doubtful whether they would acquire the desire to pursue these subjects later.

If you will permit me, sir, I would make one added point. There are many high schools in which there are literally no teachers there to do the teaching—in which the youngsters want to take the courses, but they are not available. This is largely due to the intense competition for manpower in the field of science and mathematics and the fact that as a consequence of this competition the people who would ordinarily enter the teaching profession are drawn away into science and engineering in the nonteaching fields.

Mr. BROWN. I noticed, Doctor, that we also have great demand over the country for truck drivers and taxicab drivers and chauffeurs. Seemingly, in a great many schools we now can find available the men to teach high-school youngsters to drive an automobile, but we can't find teachers to teach them some of these other basic studies.

For instance, spelling. Do you think that you can make a good student or a good physicist or chemist or engineer out of a boy that can neither read nor spell?

Dr. BERKNER. I think everyone agrees that——

Mr. BROWN. How can one gain the knowledge through reading and study if he can't actually read and spell, if he doesn't know what the words mean?

Dr. BERKNER. I would agree fully that at the high-school level a broad training is required. This training must include literature, some languages, perhaps some art, as well as science and mathematics, so that the student emerging from the high school has a basis on which he can exercise judgment in entering the university.

Mr. BROWN. I had a boy write me the other day and say:

DEAR CONGRESSMAN: I am very much interested in taking your examination for the Naval Academy—N-a-v-e-l A-c-a-d-e-m-a-y.

Another boy told me he was born at Fort Sheridan, Ill.—"S-h-e-r-r-i-d-e-n," and I am from a district where the number of college graduates is exceedingly high compared to the rest of the country.

Perhaps, if I might make a suggestion, in these studies that you are making it would be helpful if you just talked to some of the Congressmen and looked at some of the replies and grades, received from or made by high-school students in these Academy entrance examinations. They shock and give great concern to many of us and are matter of rather common discussion here at Capitol Hill at the time of the year when we give these examinations.

I wanted to bring out these points because, in my opinion, we just can't start at the top; we have to do some of these necessary things at the bottom, and must have a good foundation upon which to build a real education.

Dr. BERKNER. I would agree very strongly, sir.

Mr. BROWN. I want to thank you, Mr. Chairman, for giving me the opportunity to bring out these viewpoints, and I again wish to congratulate the doctor on the statement he has prepared and, which I have read with a great deal of interest.

Thank you very much.

Mr. MCCORMACK. Thank you, Mr. Brown.

Doctor, we will be very glad to hear from you.

Dr. BERKNER. Mr. Chairman, members of the committee, I am very happy to respond to the invitation of the committee to testify on management, budgetary, and organizational aspects of Government-sponsored scientific research and development programs. This is, of course, a large order, and I shall confine myself to those limited aspects of the question with which I am intimately familiar.

If you would permit me, Mr. Chairman, I would like to depart from my prepared statement for just one moment by remarking that this morning, in coming down in the airplane, I found a statement which might be clearly adopted as the real text for the inquiries that the committee is now making. This statement is the very first paragraph of the preamble of the final report of the 12th American Assembly, which, you recall, was founded by President Eisenhower when he was then President of Columbia University, in 1950. The American Assembly had on its rolls some of the most distinguished citizens of our country. This preamble reads as follows:

> The United States has attained a worldwide reputation for preeminence in science and technology. Whether we like it or not the maintenance of the United States' position in the image or already fashioned is a factor in the present world struggle. In such a situation, the position of the United States is inescapably competitive.

This, then, Mr. Chairman, is the very basis for the discussions and inquiries with respect to our future in science and technology that are going on at the present time.

The committee has already heard from Dr. Waterman, Dr. Bronk, and others of the urgent need for the support and improvement of scientific education at the level of both the high school and the university. It is scarcely necessary to expand on their carefully prepared views.

Mr. MCCORMACK. Would you want the members to ask questions as you go along or wait until you get through?

Dr. BERKNER. If you choose, I would be very happy to be interrupted at any time.

Mr. McCormack. You say on the bottom of the paragraph, "high school and university." That means all high schools and universities; is that right?

Dr. Berkner. Yes, sir.

Mr. McCormack. In other words, the search for brains?

Dr. Berkner. The search for brains and the raising of our standards so that these brains can be more effective.

Mr. McCormack. In any legislation that might be enacted by Congress, do you think that there should be restrictions on the utilization of brains, say, in any private school system?

Dr. Berkner. Well, sir, I presume that you would agree with me that the Federal Government has a difficult role in doing more than suggesting the level of curricula that should be used, because of the traditional separation of the powers of the Federal Government and the States with respect to the supervision of education. I do believe, however, that the Federal Government might well recognize through aid to teacher training for all schools, the need of teachers to increase their capacity to teach in certain fields.

Mr. McCormack. I had more in mind the students. Take the individual student who is interested in a higher stage of education and who has the ability, as felt after screening, and requires assistance in the college or university level and he is on the high-school level. Do you think that the utilization of brains should be confined to those in the public schools or should it embrace all of our school system?

Dr. Berkner. I think that assistance to students going on to the university should be without respect to the origin of the student.

Mr. McCormack. And, of course, you and I know that there are many restrictions on the State level in connection with the private schools, but that same restriction doesn't exist on the Federal level.

Dr. Berkner. Yes, sir.

Mr. McCormack. These are just broad questions. In other words, the private school system most States have, either constitutionally or by State laws, prohibitions against assistance to private school systems, as such—to students. Now this is a national challenge and this is something that legislation of this type is in connection with, a national interest of our country. I assume that that is the basis, that we have to develop scientists, physicists, and others, and they are not confined to that because you are not trying to eliminate the humanities. I assume you have that in mind; is that correct?

Dr. Berkner. I would say, in reply to your question, Mr. Chairman, that in meeting this challenge we should use the full diversity that our democratic system provides. This certainly means that in providing aid to students that the aid should go to any student that qualifies intellectually for the aid without regard to the school that he selects.

Mr. McCormack. You have answered my question very directly and very frankly.

Dr. Berkner. Two points are worthy of note, however. First, in advocating better education in science and mathematics in the high school, scientists are not proposing that everyone become a scientist. The real point is this: When high schools do not offer sufficient training in science and mathematics, the student loses his choice to elect science and mathematics as a career. Thus, thousands of brilliant

young mean and women are denied the opportunity to choose science as a career through neglect of school administrations and school boards. While the Federal Government can help in certain specialized ways, which have already been outlined by Dr. Bronk and Dr. Waterman, the main responsibility lies squarely on the shoulders of the local school administrations. To deliberately deny the opportunity that our country should offer to our young men and women is a rather dreadful decision, especially when it involves the standing and to some extent the safety of our country. Here is a place where every citizen can help directly.

There is a second aspect of the problem of education on which one might comment. Some feeling has been expressed by educators that scientists were advocating over-emphasis on science and mathematics at the expense of other essential aspects of education. I think that somehow many professional educators of the present century have tended to the restrictive rather than to the inclusive connotation of the word "humanities." At the beginnings of the broad educational growth of man, the Greeks clearly recognized science and mathematics as an integral part of human experience. But somehow, during the Victorian age of the last century, the word "humanities" became used in a more restricted sense, related to what the Scotch sometimes called "polite learning." In the present age when most situations depend so directly upon the products of science in their day-to-day life, it seems not unreasonable that some knowledge of science and mathematics should be properly included as a part of human experience. Certainly, in an age of electricity and jet aircraft and automobiles, radio and television, with space technology around the corner, it is not unreasonable that every human should have some basis for interpreting his surroundings through comprehension stemming from knowledge. Without some comprehension of science and mathematics, it is more difficult to act intelligently as a citizen. Certainly very few, if any, scientists would advocate that science and mathematics should be taught at the expense of other necessary elements of human development, such as literature, languages, and the art. We only ask that education take a more intelligent view of the humanities and the extent of human experience.

Mr. McCormack. I take it from what you have said, trying to read some part of your mind, that I am correct that the world we are living in today and tomorrow is an entirely different one than only a few years ago.

Dr. Berkner. Yes, sir; and it is a world in which a knowledge of science and mathematics is important for all citizens, whether he be the truckdriver referred to by Mr. Brown, or the college president, to adjust himself to our life.

Mr. McCormack. And that we have to recognize that we are in a changed world, that conditions are going to develop, whatever they may be, and we have to try to gear them along in accordance with the principles and ideals and fundamentals we believe in.

Dr. Berkner. Yes, sir.

Mr. McCormack. I was sort of trying to interpret that as a part of your mind as you were reading that last paragraph.

I agree with you. I am very interested to get your answers, Doctor, because some of those thoughts have run through my own mind, be-

cause we can only get a glimpse of the world of today, and as to the world of tomorrow, we can only get a slight glimpse.

Dr. BERKNER. It is a very exciting world.

Mr. MCCORMACK. It is, and interesting, too—challenging.

Dr. BERKNER. Let me turn then, Mr. Chairman, to more direct problems relating to the encouragement of the scientific research so essential to the future welfare of our country. In this testimony I will confine my remarks primarily to basic research since it is precedent to brilliant development and engineering, and at the moment appears as perhaps the weakest link in our scientific and technological armor.

I will speak first about the need for continuity in research. Unfortunately, important scientific research as contrasted to development and engineering has a very long period of gestation. Scientific research is an expedition into the unknown realms of knowledge where the speed of advance cannot be hurried. Creative research usually takes many years to come to fruition and involves tedious accumulation of scattered specialized knowledge, careful preparation of experimental apparatus for testing and extending our knowledge, the slow growth of skill in the manipulation of new and critical experimental procedures, and above all, the tedious study and arrangement of the data from which the clues to brilliant advances are derived. Even the most skilled scientist must become thoroughly versed in the intricacies of a problem before he can contribute significantly to its advance, and this takes time. Research simply cannot be turned on and off at will. The period of many years for fruition of most research undertakings is simply not related to the Government budget cycle. Therefore, it is imperative that steps be taken to prevent the impact of the budget cycle with its fluctuations on the support of research, if we are to keep the United States in the forefront of research progress. Literally millions of dollars have been wasted by arbitrary withdrawal of support after groups have been organized, apparatus prepared, and skills developed, but before the experiment could be carried to its conclusion and the critical conclusions could be drawn. For example, support for the first-class rocket research at the Naval Research Laboratory since the war has been withdrawn twice since World War II and competent research teams at that Laboratory have been twice broken up and their skills and equipment dispersed. Yet this research at the Naval Research Laboratory was the direct antecedent of our effort on the instrumented earth satellite. There is little doubt that had the research support behind the Naval Research Laboratory rocket effort been continuous since the war, the time scale of the Vanguard satellite would have been very different.

I might remark, Mr. Chairman, that I say these words without any reference to the party and character of the background, since I believe we are at a point where we have to reconsider our whole policy with respect to research. Up to this time there has perhaps been inadequate understanding on the part of all with respect to how research activities proceeded and should be financed and administered.

Therefore, steps should be taken with the utmost urgency to prevent arbitrary and drastic fluctuations of research support by fiscal procedures applied without regard to the consequences of their action.

Certainly, the proposal of your chairman, Congressman William L. Dawson, that a $200 million scientific research reserve fund be established—

to permit highly desirable and carefully selected scientific basic and applied research projects to be started or to be continued without lengthy delays * * *

has a great deal of merit. Such a fund, skillfully administered and employed by an appropriate agency such as the National Science Foundation, would be invaluable in stabilizing research projects that had reached a critical stage in their growth. Such a fund would save millions for the country by preventing destruction of costly research effort before it reached fruition, and the scientific stature of the Nation would be greatly enhanced by insuring that individual researches were brought to their logical conclusion. Above all, such a fund would encourage our most brilliant scholars of science to work in the field of basic research with the confidence that years of work would not be wasted and hopes frustrated by some arbitrary fiscal decision.

As a matter of fundamental policy, the fiscal and budget officers must be removed as the masters of research, if our country is to meet the challenge of our day. This is not to say that every research project is holy and should never be cut. In any large research program many projects turn in unproductive directions or reach dead ends.

Good research administration demands continual vigilance in prompt discontinuation of unproductive effort. But this must be done through frequent review of individual research efforts by a competent science administration. The level of research must necessarily fluctuate only as a slowly varying function, as research progress permits critical scientific judgment to be exercised with respect to each element of our national research program.

The Congress might well insist on such a policy. When coupled with the reserve fund that has been proposed by the chairman of your committee to effectuate that policy, American science would have a green light, and I assure you that it would be hard for anyone to catch us. But if we fail to adopt such policies, it will become ever more difficult and expensive for American science to compete successfully with other scientifically advanced nations.

Let me turn now to the level of research support. It is, of course, very difficult to ascertain exactly how much Government support is now being given to basic research, but from statistics available it appears now to be in the neighborhood of 200 to 250 million dollars.

I might interpolate that the total support for research and development for the country is probably five and a half billion dollars, but the $250 million figure represents the Government program for basic research.

We must remember that it is the fundamental research produced by this investment that will be the foundations of our technology in the years to come. In this, the Federal Government has many interests. The Government is obviously interested in the welfare of our citizens as it depends upon technology emerging from research. But research support is also directly related to Government income. One might estimate that the top half of the United States income is derived from the ideas emergent from research since the turn of the century. This is the portion of the national income that provides the major source of revenue to the Federal Treasury at the present time.

As the national income from ideas emergent from research increases, not only is employment increased, and industry and its product to our people expanded, but likewise the income to the Federal Treasury is enhanced. Therefore, Federal investment in research must be

looked upon as a capital investment that will produce direct revenues to the Federal Treasury. As capital, the ideas from research have permanent value as an investment, and are never lost, nor do they require maintenance to insure their ever-continued contributions to our economic intellectual community and to our Federal Treasury. Even without the need to achieve national preeminence in technology, we would be justified in greatly increasing the Federal support for fundamental research as a continually rising source of Federal revenue.

The level of support for basic research might well be adjusted to the employment of all competent and creative members of our scientific community in the quest for the advance of knowledge. To the extent that this can be achieved, our national scientific stature will proceed forward at an optimum rate. I would expect within the next few years we would be justified in increasing the total level of support for fundamental scientific research to 4 or 5 times its present level. Certainly, our support level must be geared to absorb the best qualified men emerging from our enhanced program for improved and advanced scientific training. Failing this, our technology will more and more be based upon obsolescent and obsolete scientific ideas. In achieving this level, our Federal Treasury will be more than repaid for the monies so spent, and our national future will be provided with splendid and evermore efficient technological opportunities.

The balance of our research effort must be given very close and continuous scrutiny. At the moment, the level of support for some fields of research is substantial. In other scientific fields we have denied our scientists the means and the tools essential to major progress, thereby preventing them from assuming the leadership for which our Nation should provide.

In examining the balance of research support, we certainly cannot fail to recognize the critical importance of the creative individual in the final development and ordering of the facts and ideas emergent from research, and their expression in concise form. Support for such persons is imperative. It has often been the excitement of dedicated individuals in pursuing some obscure clue to nature, unnoticed or undeveloped by his predecessors, that has unlocked the door to a major scientific advance. It is the imagination of individuals that ultimately generates scientific perspective from which new and brilliant attacks on scientific problems can be organized. Therefore, in a society that would increase its intellectual contributions to science at an optimum rate, the opportunity for experimental and theoretical research by the individual must be supported to the extent that competent persons are in need of and available for such support. It is no accident that persons best suited to individual research are most often found on the faculties of the colleges and universities. The diversity of the university atmosphere reacts to broaden the interest of the individual and to provide the intellectual tools required for association of diverse facts. Moreover, the need for clear presentation of new ideas to the student forces a clarity of thought and expression on the part of the research scientist that often contributes to concise formulation of scientific truths. Therefore, extensive support for the research workers of the university faculties will produce great benefits.

But aside from support for such individual effort, there has been a rising need for research facilities which are competent to meet the demand of the more difficult research problems. We have already

seen such demands in the field of nuclear energy where support for the great accelerators and the huge nuclear reactors by the Atomic Energy Commission has been necessary. Some of the great national laboratories have been found essential for this purpose. The need for central national laboratories to augment university facilities by providing large machines for particular research problems has emerged in many countries in recent times. The Max Planck and Heinrich Hertz Institutes of Germany have grown in response to these needs. In addition to its universities, the Soviet Union has developed a whole series of distinguished institutes that extend across the whole field of science. The CERN Laboratory at Geneva, constructed through the cooperation of several European nations, is an especially important case in point.

In many fields of science, major progress is essentially impossible without research tools that are capable of dealing with the limit of man's knowledge. Quite evidently, the individual must have access to the kind of instruments required to solve his problem or science will become stultified. But large research tools are often expensive, and no nation can afford to build or operate very many of them. Limitation on funds and the required efficiency of operation requires that a single such instrument, in many cases, serve the needs of scientists from many universities. Thus, the national laboratory or institute is designed to provide access by the scientists of university faculties throughout the country to such great scientific tools and means.

In astronomy, for example, the large telescope is imperative to extend the vision of science beyond the bounds of our present knowledge of the universe. A dozen small telescopes scattered among widely separated locations can never provide the kind of facts that a single great telescope can produce. The small telescopes are essential to the universities for specialized research and training, but the large telescope is imperative to the Nation if the bounds of our knowledge are to be extended.

The need for the facilities that only the national institute or the national laboratory can provide is apparent in many fields. At the moment, for example, research in meteorology is very restricted by the power and quality of the tools at hand. Meteorology is not limited by lack of adequate clues to nature, for they are prolific and exciting. But to explore these clues men require very large and unique tools, and the opportunity for rather massive group attack on the secrets of the atmosphere. These large tools are necessary because the phenomena of meteorology occur on a planetary scale and man must be prepared to attack these problems by means of planetary methods. Aircraft with precise instrumentation are required to explore the properties of hurricanes in the Carribean, the typhoons in the Pacific, and the tornadoes in the great land areas. They are required to observe the fueling of the atmospheric circulation by consistent observation of minute traces of natural and artificial atmospheric radioactivity.

Satellites—and I emphasize the plural—must be put on patrol to observe continuously the earth's heat balance and the minor local fluctuations of that balance, to map the storm systems and their movement. The design and control of such precisely instrumented earth satellites, and the reduction and analysis of their data, involve a major and continuing effort.

I might emphasize, Mr. Chairman, that the advent of certain properly instrumented satellites, if suitably employed, promises the addition of a very important tool in the revolution of our understanding in meteorology, which, of course, affects everyone of us in many important ways. Very recently, at a meeting of meteorologists held at Hartford, the American Petroleum Institute stated that if seasonal forecasting could be improved only 10 percent, it would represent a savings of a hundred million dollars a year because, of course, of the foreknowledge of the amount of fuel that would be needed in any particular area.

Rain towers, wind tunnels, and especially very fast computers required to solve the unique problems of atmospheric flow are essential to the delineation of the earth's general circulation, the study of cloud physics, and the like. Meteorology is but one example of a scientific area where research has become rather sterile and disjointed for the crying want of tools and means to break the bonds of ignorance on a planetary scale. A properly equipped national institute or laboratory functioning in close collaboration with the universities could do this job.

Likewise, problems involving the need for institutes or national laboratories are evident in the field of oceanography and of other areas of science where the scale of the problems is far beyond the capacity of individuals of university faculties to undertake, working by themselves with their limited resources. A start has been made by the National Science Foundation in establishing the National Radio Astronomy Observatory at Green Bank, W. Va., and the National Astronomical Observatory in Arizona.

Unless such institutes or national laboratories are established wherever their need is essential, because of the scale of the problem, American science will simply continue to lag in that area of activity.

The critical need for laboratories of the general character that we now define as national laboratories is not new. Early in the history of astronomy its progress became dependent upon systematic observation of the stars with large and expensive equipment. Lacking the large and expensive instruments needed for this systematic accumulation of data, astronomy had been bogged down for a thousand years in astrology and mysticism. Even before the invention of the telescope the Danish astronomer, Tycho Brahe, with the generous patronage of King Frederick, built his celebrated observatory of Uraniborg on the island of Hveen in Denmark. Here were housed the mighty quadrants and sextants and the great globe that were the wonder and admiration of the 16th century scholars, who were attracted by the opportunities, facilities, and intellectual strength of the observatory. Later, I might add, due to budget cuts by King Christian, the son of King Frederick, Brahe moved his laboratory to Prague under the patronage of Rudolph II, where he was joined by men like Kepler. The observations made possible by this early form of what has now become the national laboratory, made the fundamental contributions that have led directly to the detailed specifications of the heliocentric concept of our planetary system. From this step the general laws of motion and gravitation were conceived and modern engineering was founded. Though these observatories, in terms of money of that day, were comparable in cost to the present-day national laboratories, they were the vital keys to bringing scientific progress

out of chaos. No amount of individual observation in absence of the instruments at Uraniborg and Prague could have assembled and ordered the basic scientific data that underlay this first great step toward astronomy and mechanics.

Unfortunately, in the study of the macrocosm—the universe—and the microcosm—the atom—large and expensive tools are necessary to order and to convey the phenomena to our simple senses. Even in the study of the earth itself, highly organized and extensive efforts of thousands of scientists and scientific operations over its surface are necessary to provide a scientific view of the earth as a planet.

To explore the tiny structure of the atomic nucleus and its nucleons; that is, protons and neutrons, we must use a form of "light" whose wavelength is comparable to the size of the particles we would observe. Wavelengths of such small dimensions can be generated only with energies amounting to billions of electron volts. Therefore, giant machines, such as the cosmotron at Brookhaven or the bevatron at Berkeley, are required to explore the atomic nucleus and to analyze the subatomic particles of which it is composed. Nuclear reactors are needed as a source of neutrons for a multitude of research activities that explore into special properties of atomic nuclei.

As one studies the earth, the means of observation must be comparable to the scale of the phenomena that we would understand, predict, and control. Moreover, as one presses in other directions toward the ultimated boundaries of thought, one encounters the need for very large and expensive computers to aid the human brain in the quick solution of problems that are susceptible to the application of repetitive processes. It was primarily out of the requirement for a variety of large research tools that could challenge major limitations on knowledge that the national laboratories came upon the scene of American science during and since World War II. The national laboratory has emerged to satisfy a number of very well-defined needs: First, the need by individual scientists for access to certain large and expensive research apparatus for the conduct of critical experiments; second, the need for the systematic collection of scientific data whose ultimate synthesis and organization is essential to the advancement of basic scientific thought—that is what Tycho Brahe did toward the end of 1500; third, the need to provide opportunity for men of diverse scientific disciplines, unencumbered by extensive teaching commitments, to carry out group research, particularly in the interdisciplinary fields where their joint skills are essential to the solution of difficult and complex problems; and finally, the need for suitable facilities provided in a stimulating atmosphere where thoughtful scientists of many faculties can meet together for extended intervals in the shadow of the best scientific instruments to examine into all facets of particularly challenging and difficult scientific problems with adequate experimental support at hand.

The tax burden, bred of a succession of wars and national emergencies, now largely prevents the accumulation of private fortunes sufficient for the patronage of the really large-scale activities that some disciplines of present day research require. Only governments, or in many cases, groups of governments have the resources to support these large-scale scientific activities. Furthermore, the operation of some of the new research facilities is often unsuited to the university campus. Quite aside from the fact that the cost of some machines

and their associated laboratories may be comparable to the entire budget of the university, the extent of the investment imposes the need that the machine be operated in the interest of research with reasonable efficiency—that is, as continuously and on as wide a range of research problems as appropriate. Moreover, it is necessary that the machines be used for systematic series of observations—not dissimilar to the need for systematic observations of the stars—and this requirement may tend to divert the university staff from pursuits better suited perhaps to their desires and capabilities and their teaching.

After the war, for example, the conclusion that the national laboratory was the most suitable organizational device for the construction and operation of very large scale, and often unique, research tools for the benefit of American universities led to the development of the Brookhaven National Laboratory, which is operated by my organization, under contract with the Atomic Energy Commission. The research tools of Brookhaven were planned to supplement the facilities available to the scientists at a large number of universities, so that any qualified American scientist might feel that he could have access to machines of whatever size his experimental program required.

Mr. McCormack. How could they get permission, Doctor?

Dr. Berkner. If they are qualified, Mr. Chairman, they simply apply to the Director or to the department head involved. Their problem is assessed and the scientists' skill is assessed and if it is appropriate, they are scheduled into the machines. It is an important advance in our scientific organization because it does provide the machines to a large number of universities and at Brookhaven, at last count, I recall something more than a hundred universities whose faculties were making use of these large tools in one way or another.

At this point, however, I must enter one caveat. There is obviously a limit to the research that even a large machine can carry out in a given time. I might add that our cosmotron is scheduled for enough work to keep us busy for perhaps 20 years ahead. Actually, when operated properly, the research capacity of a great machine can be very large, and it becomes a very cheap research tool in spite of large capital investment. The research reactor at Brookhaven supports some 60 to 90 experiments simultaneously, with an added 100 more that involve the short-lived isotopes that the reactor can produce. The cosmotron has done as many as 4 to 6 simultaneous experiments by careful technical planning. Such machines must operate around the clock. As we learn better to handle such tools—for example, bring the beam into alternative and more suitable target areas; increase intensity; improve the basic facilities—their experimental efficiency can be steadily improved. But even with every economy of effort, there are inevitably demands upon the machine for research activities far beyond its capacity. Consequently, the great machines certainly cannot be used for education or training activities in the ordinary sense, because its capacity must be reserved for those experiments likely to extend the boundaries of knowledge most effectively. Furthermore, the investment of some $30 million for a 30 billion electron-volt accelerator imposes the requirement that its time be devoted to only the most significant research problems, so that this investment can be justified. In other words, the primary function of the National

Laboratory must be pure research at the most advanced level, with educational activities as distinctly secondary.

Anything that can be done with smaller machines at the universities should most certainly be done there in the interest of efficiency and economy of our national effort. In the field of training it is the job of the universities to provide the facilities necessary to training and research that will produce the scientists who will eventually use the great machines at our national laboratories. This means that there must be many smaller machines—reactors, accelerators, computers, and telescopes—at the universities so that the level of training and progress on research problems will be sufficient to ensure effective employment of the larger machines at the national laboratories. When machines for training and smaller-scale research are beyond the resources of the university, then the Federal Government, through such agencies as the National Science Foundation, the Atomic Energy Commission, or the Department of Defense, with its specialized agencies such as the Office of Naval Research, must provide the necessary financial help so that research and education in our universities can meet the demands of today's science.

Mr. McCormack. Could something of a regional nature be devised?

Dr. Berkner. I think, Mr. Chairman, that inevitably the national laboratories will be regional in character, but not entirely so. Many of the laboratories will provide distinct facilities or skills in certain areas of science which will attract scientists not only from the whole country, but from all over the world.

It is natural, of course, that universities nearer to a laboratory tend to use it somewhat more and that just one national laboratory in a country as great as ours may not be enough in any one field, but I think that we must look at the needs of the universities themselves, rather than to build them simply because the pride of one area might lead it to feel that there ought to be a laboratory in the area. The provision of national laboratories should be based on a national need.

Mr. McCormack. My question on regional was in connection with your statement here that this means there must be many smaller machines—reactors, accelerators, and so forth.

Dr. Berkner. I think that there must be many of these individual laboratories.

Mr. McCormack. Yes, but I mean couldn't several universities, where it would be beyond their ability to bear the expense, arrange for some location reasonably available to them?

Dr. Berkner. Certainly they could, Mr. Chairman, and this would be a very good idea, but when they do this, the resultant facility begins to take on the character of a national laboratory and it may be that at sometime we can afford to have enough national laboratories to carry on educational training in these laboratories.

Mr. Lanigan. Could I ask a question?

Mr. McCormack. Mr. Lanigan.

Mr. Lanigan. Couldn't the State and local governments also support laboratories more on a local level? For example, in the city of New York there are a number of universities, and in the city of Washington there are a number of universities. Wouldn't it be appropriate for the local governments to have a laboratory through which this group of universities located in the particular cities or other small areas would work?

Dr. BERKNER. This would certainly be possible. Of course the States have contributed very strongly already to the support of moderate-sized tools at individual universities for which they are responsible.

For example, I recall that Professor Williams, at the University of Minnesota, if I am not mistaken, got the money for his large accelerator at the University of Minnesota at least in part from the State of Minnesota and this accelerator is operated by funds provided in part by the State. I believe there are many such examples of the operation of moderate-size tools by the State for educational and limited research objectives.

Mr. HENDERSON. Doctor, as I follow your testimony, you are making a major recommendation here that there should be an extension of the national laboratory system program as it exists; is that correct?

Dr. BERKNER. Yes, sir, very definitely.

Mr. HENDERSON. Are you using Brookhaven as an example of what you would like to see around the country?

Dr. BERKNER. I think Brookhaven is a very characteristic example in that it has developed so that it serves a very large number of universities.

As I will mention in a moment, about half of the research staff is on the roles of the laboratory itself and about half are visiting scientists. This turns out to be what we believe to be an optimum balance.

Mr. HENDERSON. Now, Doctor, is Brookhaven owned and controlled by your organization or is it owned and controlled by the Federal Government?

Dr. BERKNER. Brookhaven is owned by the Federal Government and operated under contract by our organization.

Mr. HENDERSON. By your organization?

Dr. BERKNER. Yes.

Mr. HENDERSON. And you think that this might be adopted or, rather, extended to other fields in other parts of the country, where the Government itself would put up the money, set up the laboratory and then contract it out to a group of universities, possibly, or some other similar type of organization to operate?

Dr. BERKNER. This is precisely what I am recommending. Now pointing out that facilities of this kind in many fields provide the only means of attacking very important scientific problems, and you will recall that I used the example of meteorology as one in which great progress could be expected if this type of organization were adopted. I recommend this because I think we have seen a pattern which works very well. It is very successful.

Mr. HENDERSON. I merely wanted to get the precise role of the Federal Government in the program that you proposed.

Dr. BERKNER. The Federal Government provides all of the capital funds and the greatest share of the operating funds in a laboratory of this kind.

Mr. POLAND. In what budget would those be found?

Dr. BERKNER. In the budget of the Atomic Energy Commission.

Mr. POLAND. Both the capital and operating funds?

Dr. BERKNER. Both the capital and operating funds.

Mr. MCCORMACK. Have you in mind how many additional national laboratories should be our goal?

Dr. BERKNER. This would be very difficult to answer, Mr. Chairman. I think it would be far better if the Federal Government adopted as a policy the recognition that these national laboratories should be established when the research objectives could be achieved in no other way. If this policy were adopted, then a number of scientific groups could prepare to present needs to the Federal Government in different areas of science. I have mentioned already some of these areas. Meteorology is one, oceanography is another. One can think of others in which the national-laboratory technique might insure the continuance of our scientific preeminence by providing our scientists with the very best tools.

Mr. MCCORMACK. The location, the atmosphere would be an important element in the location, where there are other schools of engineering and science and so forth.

Dr. BERKNER. Sometimes laboratories have to be selected for very specific geographical reasons. For example, when the National Radio Astronomy Observatory was established, the whole of the country east of the Rocky Mountains was surveyed very thoroughly to find the best possible physical location. Quite remarkably, one location stood head and shoulders above all others because the apparatus would operate at least 10 times as effectively in that location. This was in a little valley surrounded by five mountain ranges, which protected it from radio noise. It is known as the Green Bank Observatory in West Virginia. Quite clearly there was no other site that even approached it. Here, you see, a technical requirement relating to geography determined the site.

Mr. POLAND. How does the Federal Government retain any program control over the facility which it has bought and which operating expenses it pays?

Dr. BERKNER. Through the budget.

Mr. POLAND. Where does the contract come in there?

Dr. BERKNER. The contract specifies how the money shall be spent and the general areas in which the work should be carried out. But scientific judgment exercised on behalf of the Federal Government in the budget-making process can determine the direction in which these programs should be financed.

Mr. POLAND. That becomes a specific clause or provision in the contract or arrangements which you would have then with the Atomic Energy Commission?

Dr. BERKNER. Yes, sir, or it can be auxiliary to that contract arrangement. The most desirable way of financing is on a program basis; namely, that we and the Atomic Energy Commission at Brookhaven, for example, agree that the level of activity in the field of the natural sciences—physics and chemistry—should be so much; the level of activity in the life sciences—biology and medicine—should be so much; the level in the field of nuclear engineering and chemical engineering should be a certain level. These levels are studied each year.

Mr. POLAND. Those levels, are they fiscal levels or production levels?

Dr. BERKNER. They are fiscal levels.

Mr. MCCORMACK. Is biology given the consideration it warrants?

Dr. BERKNER. Yes, sir, I believe it is. At Brookhaven we have

levels for biology and medicine which approach the levels of the natural sciences.

Mr. McCormack. Biology, from the angle of military activities, could be biological warfare, and from the angle of military activities it could be very important.

Dr. Berkner. Yes, sir, but that is not our principal interest at Brookhaven. Because of our access to radioisotopes—an adequate supply of neutrons, gamma rays, et cetera—our effort is directed to the study of the biological effects of radiation, genetics and the application of biological effects and genetics to various fields of technology.

You may recall before the Congress some evidence given 2 or 3 years ago in which it was possible to produce a rust resisting strain of oats which not only would resist, but would have stronger stamina and would produce better. This is very nice to get and it can be obtained through increasing the rate of genetic change, using neutrons or gamma rays.

Mr. McCormack. Yours is more for peaceful use, more for peaceful activities?

Dr. Berkner. I wouldn't say that, Mr. Chairman; I would say that all science can be used either for military or peaceful purposes. This is a matter of human choice as to how it is employed.

Mr. McCormack. I am thinking of the immediate problems that confront the world of today. We have to meet the immediate concern to be able to go ahead effectively under a free government and try to meet the problems of the long-range concern.

Dr. Berkner. That is true. Often one says that if you are working on a particular weapon system, that you are working on the side of war, rather than on the side of peace. I am not sure that this is correct because very often in doing very fundamental research on weapons you are disclosing information that in addition to providing more powerful weapons also provide peaceful applications if you choose to use them that way. So I would say that all science is applicable both to peacetime and wartime pursuits. This is one of the very desirable results of our military research and development. While it may increase our national strength in a military sense, it also has the productive effect on our peacetime pursuits.

Mr. McCormack. Mr. Fascell.

Mr. Fascell. Mr. Chairman, I want to be sure I understand. Am I correct in saying at the present time you are doing no applied work in Brookhaven?

Dr. Berkner. We are doing a great deal of applied work in the field of nuclear engineering and chemical engineering.

Mr. Fascell. This is not military applied?

Dr. Berkner. No, sir; this is in the reactor field, the study of a very advanced reactor configuration.

Mr. Fascell. Then in the establishment of fiscal levels for programing, Doctor, is this the only determination that is now in use between the Laboratory and the Atomic Energy Commission?

Dr. Berkner. The procedure, of course, involves rather detailed reporting by the Laboratory on its progress in various fields.

Mr. Fascell. This assumes that somebody can understand it and evaluate it.

Dr. Berkner. That is correct. There must be people in the Commission who can understand and evaluate it.

Mr. FASCELL. I won't ask you the obvious question then.

Dr. BERKNER. I must say, in answer to the obvious question, that the Commission has shown, in my opinion, unusual skill in its staff work on evaluating the project.

Mr. FASCELL. Or to say it another way, you continue to get the money necessary to operate.

Dr. BERKNER. Not only that, but we can discuss with the Commission, rather intelligently, the desirability of following this or that lead.

Mr. FASCELL. That leads to really the main question I had, Doctor, which is how is the determination made on continuity here. Once you get to a program, does that establish it for all time at a fiscal level that can't be changed?

Dr. BERKNER. No. These programs are adjusted year by year, either up or down.

Mr. FASCELL. I know, but you still have the same program. You are either spending more money or less money.

Dr. BERKNER. The program is a very general one, and the specifics of that program are under our direct control. This is so that if we run into a dead end on research project on November 15, we don't have to go on and spend money on it until next June; we can cut that project.

Mr. FASCELL. Or vice versa?

Dr. BERKNER. That is right.

Mr. FASCELL. Which is if you find a very desirable field to explore, you are not bound by the limitation of money; you can throw the money into this desirable field; isn't that true?

Dr. BERKNER. That is correct.

Mr. FASCELL. This is the only way you can get any productivity out of these programs; otherwise you would be stymied.

Dr. BERKNER. The leeway the Commission allows us in our programs is highly desirable and I think very economic.

Mr. FASCELL. All right, sir. This is a very fine method of operation. I would like to ask you then, in general isn't it possible for the universities who are trying to do the same kind of job on a smaller scale to get the same kind of contract? At the present time they are all getting 1-year contracts.

Dr. BERKNER. Our contract is a long-time contract, but financed on a year-to-year basis. This is a serious matter to us because the Congress, or the Bureau of the Budget, through the holdup clauses, could cut our funds very radically in one year. Then it would do incalculable damage to research progress. It would be more economical if you want to cut to slope the cut so that you could bring projects to conclusion in logical order, rather than cut them off so many times just before the project came to its logical conclusion.

Mr. FASCELL. Then, as I understand it, you agree with me that a 1-year research contract for basic research with the universities, which is subject to the normal budgetary process of either being included or not included, without the right to researching staff of a particular university to determine its program on a continuous basis is actually a waste of money?

Dr. BERKNER. May I answer that very bluntly: It doesn't make sense.

Mr. FASCELL. Thank you, sir. You would therefore recommend a very definite change in our present method of allowing research contracts to universities?

Dr. BERKNER. Yes, sir. But we must have some source of continuing money so that the research projects can be brought to a close in an orderly fashion. This doesn't mean that the Federal Government doesn't have control of the money it puts into research, but the effects of its control may show up some years later in order that research projects can be productive.

Mr. MCCORMACK. Any further questions?

Mr. FASCELL. I have some others, but I would rather have him finish his testimony, Mr. Chairman.

Dr. BERKNER. Experience has shown that optimum progress and most effective use of research tools at the national laboratories seems to be achieved when the research effort of the permanent staff of the laboratory and of the visiting is about equal. This does not mean that there is an exact 50–50 division of their numbers in residence at the laboratory at any one time, for a visiting scientist at a national laboratory may have spent months or even years in the preparation of his experiment at his own university, and may spend an equivalent time at home, working up his results after his experiment is completed. Therefore, the actual proportions of research between permanent and visiting staffs of the national laboratory are always very difficult to ascertain and will vary from problem to problem. Nevertheless, in a general sense, the 50–50 estimate of overall permanent and visiting research effort is probably not far from the optimum. Under such an arrangement, the staff acquires a number of important advantages: First, the visiting scientist can work with experienced people in setting up his experiment on a large and, perhaps, unfamiliar machine; second, the extended contact between visiting scientists and permanent staff leads to an important interaction of ideas among both groups; third, the growth of thought in the national laboratories can serve as a stimulus to the thought of the university faculties.

Mr. MCCORMACK. That is very important, Dr. Berkner.

Dr. BERKNER. This is very important for transferring ideas from the national laboratories back to the universities. And I might add that the flow of staff back and forth between the national laboratories and universities is a very desirable and very effective way of keeping the universities actively up to date in the progress of some of the advanced research that goes on in the national laboratories.

It has sometimes been thought that great facilities might be established without a strong supporting scientific staff, so that they might be available solely for visitors when they feel the need for the use of such facilities.

This, in my opinion, is a dangerous concept and, to my knowledge, it has never been successful in any case. Therefore, such basic facilities must be provided of a central nucleus of capable staff and the auxiliaries needed for the full scientific activity of both the staff and the visiting scientists. Only in this way can the national laboratory create the visions of opportunity and the attraction of research excitement that are essential to the creative use of such facilities by the faculties of our universities. This principle has been outstandingly demonstrated in the performance of our existing national laboratories,

which have stimulated activity recognized by a surprising number of Nobel prizes.

One can now safely say that the National Laboratory as an essential element of American scientific activity has grown far beyond the original concept of Tycho Brahe. The wise interaction of our democratic, social, and political processes has brought together Government, on one hand, and academic groups, on the other, to contribute a unique element of strength to the maturity of the American intellectual scene. Academic tradition is not built in a decade, of course, but I believe it is safe to prophesy that the National Laboratory will stand as one of the major intellectual innovations of our time. Thus, by careful design, the National Laboratory can provide the tools and means to make the boundaries of knowledge in every field of science accessible to the faculties of our universities.

They can provide these facilities in the most economically possible way, and thereby create instruments available to American science that are second to none.

But to accomplish this task we will require a national policy that recognizes the need for such facilities and that provides for their financing and growth. The policy must allow such facilities to grow naturally as a part of our national academic and scientific strength without interference and restriction by administrators of Government funds through imposition of preconceived theoretical notions of management. Experience, and not inexperience, should guide their form of growth. Most certainly, the cost of their establishment will be very substantial. But these costs will be abundantly repaid, not only by the opportunity for leadership thus made available to American science, but also by the production of ideas that will inevitably emerge from a real ability to explore the boundaries of our knowledge.

Thank you, Mr. Chairman.

Mr. McCormack. Could you give us an approximate idea of the cost?

Dr. Berkner. A national laboratory, let's say, to do the job in the field of meterology, would probably involve a capital cost of approximately $50 million over a period of 5 years, and an operating budget about one-third of the capital cost, perhaps about $15 million a year.

Mr. McCormack. Any questions? Mrs. Harden.

Mrs. Harden. No; I had that question in mind, Mr. Chairman, but it has been answered. Thank you.

Mr. McCormack. Mr. Fascell?

Mr. Fascell. Yes, Mr. Chairman. I am glad to see one statement you put in your conclusion.

Mr. McCormack. Off the record.

(Discussion off the record.)

Mr. McCormack. I wanted to be at this meeting, to stay here to listen to your entire testimony, which I have read and followed with very deep interest, because we realize the value of your thoughts, based upon, not only your years of deep and intensive study, but equally your years of experience which has brought about a wisdom which is worthy of profound consideration. I know I have to leave, so I ask you if you will understand. The reason that I have to leave is that I have to go to another important meeting. I leave you in the hands of a better chairman.

Dr. Berkner. Thank you, Mr. Chairman.

Mr. FASCELL (presiding.) I was very pleased to see your statement. In dealing with the problem of administration, in this whole concept, it would appear to me this is something that we just cannot skip over lightly and needs to be emphasized quite strongly. As a matter of fact, maybe it needs to be more than just a national policy. And I do not know how we can get to it. That is, the necessity of eliminating too tight an administrative policy over research funds. Now, I assume, from the fact that you put this statement in here, that this is somewhat of a problem?

Dr. BERKNER. It is always a problem. It is a problem on the part of the Federal Government, and it is a problem on the part of the unit that receives the funds. On one hand, of course, the Federal Government, very properly, wants to exercise every measure of control to insure that public funds are not spent improperly in any way. This is certainly a very proper function on the part of the Federal Government and its administrators. But, on the other hand, too tight a control may lead to the real management of the research by the Federal Government as contrasted to the management of the funds by the scientists who need to do the research. And this can lead to very unimaginative research, as contrasted to imaginative research.

One must remember that, when you are pushing the boundaries of knowledge, it is not often obvious as to just where the solution lies, and to the individual who does not have responsibility for the research, he may deem at any one time that the scientist is following rather foolish directions. But it is out of these opportunities to push in new directions that the greatest discoveries come.

Mr. FASCELL. Well, as a layman, I would think it would be quite impossible to step in on the second year of a program and determine its direction, without having followed it from the beginning and having all of the basic scientific knowledge to evaluate where you are going.

Dr. BERKNER. Even the administrators within the laboratory have to use a very light hand with respect to the direction of research, because even a good scientist may find it very difficult at any moment to evaluate precisely how the research is going. Nevertheless, it is necessary in the administration of research to carry on a more or less continuous assessment of the progress on the problem so that you can join with the scientists to terminate the research if it really is getting down to a dead or unproductive end.

Mr. FASCELL. Getting this type of administrative control which would allow for an optimum of research and still carry the necessary administrative control, how can this be achieved?

Dr. BERKNER. Only through wisdom. After all, the man who controls the money usually sets the regulations, and under any set of regulations he can either go farther or less far in the weight of the hand that he puts on the research itself. Consequently, it does require very good judgment at the Government levels in administering these research controls through the control of the budget.

Mr. FASCELL. When it is controlled, however, it is spread through 15 agencies, departments, bureaus, boards, and commissions and a few other places, does the path seem insurmountable?

Dr. BERKNER. Well, we have one advantage. The diversity of control exercised by the different agencies gives us an opportunity to test

the effectiveness of different kinds of control. Here the advantage of American diversity is well illustrated. For example, if you asked scientists who they would like to contract with, many of them will say the Office of Naval Research simply because they know that this office has developed the greatest skill in the handling of pure research contracts.

Mr. FASCELL. That is very interesting. I have in mind a case which shall be unlabeled, of a 1-year research contract that, in order to get the extension for the contract processed in time to make the extension valid, you had to file for the extension at the time you got your original contract. And by the time you got your extension the contract has expired, 6 months have gone by before you got scientific approval of the extension, much less the actual signed contract for the 1-year extension.

This is the kind of administration I think is——

Dr. BERKNER. This is not uncommon. I might point out, Mr. Fascell that one of the reasons that the Office of Naval Research has been so skillful in the administration of its contracts is that because it has given it a certain amount of what is called no year money by the Congress. This is money that permits advanced planning. Therefore, the Office can deal with its research levels effectively by evaluating each year what it really wants to cut off, in consultation with research people, by keeping the balance continuously without any sharp cut.

Mr. FASCELL. That brings up the next question, Dr. Berkner. Shouldn't all research money be no-year money?

Dr. BERKNER. Perhaps all of it should be—but not all of it need be; there should be a sufficient reserve of no-year money in the Federal Government to insure this gradual rise or fall in the research level, which is consistent with the achievement of research objectives.

Mr. FASCELL. Do you have any questions?

I am sorry, Congressman Meader?

Mr. MEADER. Mr. Chairman, I appreciate your permitting me to ask a question or two. I am very much interested in this question of Federal support of research and development projects, and I would like to ask Dr. Berkner a question or two.

I wonder if, as a background for the question, with reference to projects now being financed with Federal funds if you could tell us briefly just what contact you have had with federally financed research and development programs?

Dr. BERKNER. Well, Mr. Chairman, up to 1940, for some years, I was with the Carnegie Institution of Washington, in which we had no Federal money whatever, but operated purely on its own private sources.

From 1941 to 1946, I was on duty with the Navy, and organized—as you probably know, I am a rear admiral in the Naval Reserve now, so I have kept my contacts very close—and organized a great many activities in the field of radar, electronic countermeasures, air navigation, and the like.

During that assignment I organized the Electronic Material Branch of the Bureau of Aeronautics and at that time had the opportunity to work very closely with the organization of the Office of Naval Research.

Subsequently to that time, working again with the Carnegie Institution, I took time away as the first Executive Secretary of the Re-

search and Development Board in the Department of Defense. Subsequently I worked for a while as one of the Special Assistants to the Secretary of State in organizing the mutual defense pacts underlying the North Atlantic Treaty Organization that now represents our military aid program.

Since that time I have been president of Associated Universities, Inc., principally engaged in operating the Brookhaven National Laboratory, under contract with the Atomic Energy Commission, and the National Radio Astronomy Observatory under the new contract with the National Science Foundation.

Mr. MEADER. Dr. Berkner, my first question is, in your judgment, has the Federal Government been putting sufficient funds into the research and development programs? I am talking now only about the total. I think you mentioned the figure of $5½ billion. I am not talking now about which aspects of research are supported, but the total amount of money. In your judgment, has that been adequate?

Dr. BERKNER. I find it very difficult, Mr. Meader, to know just where the line is drawn between engineering and applied research on one hand and basic research on the other. Let's say that the $5½ billion does include everything, even the engineering for new devices. One suspects that if you put more money in fundamental research, so that you did not have to engineer so many obsolescent devices, that the total might not have to increase appreciably.

Mr. MEADER. In other words, you would not criticize particularly the $5½ billion as being inadequate, but you rather think that the expenditure has been out of balance, that perhaps more should go into basic research and less into development and production in its initial stage?

Dr. BERKNER. I think $5½ billion has to grow steadily. After all, it is only a little more than 1 percent of the gross national product, and yet it is right at the basis of the great proportion of the gross national product. It is very likely in the future, with the introduction of technology, that this will have to grow slowly. But I do believe it is more urgent now to increase the basic research funds than it is to increase the total.

Mr. MEADER. Have you had experience with the manner in which people responsible for the expenditure of these funds have performed their functions? Has there been an unnecessary duplication of effort, have there been unnecessary delays in the procedures for processing applications and approving projects, and approving the expenditure, actual payment of money on projects? Have you found any difficulties on the administrative end of the research and development program financed with Federal funds?

Dr. BERKNER. Speaking of the difficulties, over the past 10 years, the more serious difficulty is the arbitrary exercise of fiscal judgment on the part of the Budget Bureau, either in support of or the allocation of funds for research. There have been very serious ups and downs. The effect of these on the output of our research has been the most serious problem with which American science has had to deal.

Mr. MEADER. Are you familiar with the testimony of the Army Research Director, William H. Martin, before the House Armed Services Committee, which was reported in this morning's press?

Dr. BERKNER. I am afraid I did not see it.

Mr. MEADER. Well, the headline is "Too many budget experts hinder defense research." I take it from what you have said that you more or less see eye to eye with Dr. Martin?

Dr. BERKNER. It depends on how you define the word "budget." It seems to me a budget expert should be one who has to judge the total national need. Now, very often I get the impression that budget experts are people who only know how to cut money. As you know, in our own private life, sometimes a wise investment is very profitable. It seems to me that a budget expert should properly judge the total national need before he makes any move to either increase or diminish the expenditures in any field.

Mr. MEADER. Do you care to cite any examples where you think a worthwhile project has been stifled by budget experts?

Dr. BERKNER. I mentioned one in my testimony, namely, the fluctuation and the level of support of the rocket work on the Naval Research Laboratory, which has reflected in the delay in our launching of the sputnik.

Mr. MEADER. Incidentally, I noticed the dates were not mentioned. You said twice it had been stopped?

Dr. BERKNER. I believe once during a Democratic administration and once during a Republican.

Mr. MEADER. I was hoping that would be your answer. [Laughter.]

But aside from this stopping of projects which you regard as worthwhile, and the exercise of judgment by a nonexpert or budget man rather than a scientist, do you have any comment on the procedures, are they unnecessarily involved is there too much red tape, is there a delay in research and development programs because of red tape and bureaucratic procedures?

Dr. BERKNER. There certainly is, and I think this is largely attributable, not to the bureaucracy so much as due to the dreadful shortage of money. These people administering those funds feel that they have to weigh all of the proposals very carefully to see where they put their money.

Now, I have a case of a scientist of very great eminence who has recently written me and said, "Look, I have just made a discovery"—I am not going to mention what this is, Mr. Congressman, if you will permit me, because I suspect this may get classified before we get done, and it perhaps should be—and he said, "I now need about $250,000 to really see this through, to get the job done."

He said, "This is quite clearly beyond the capacity of the Office of Naval Research, or National Science Foundation, with their present budget, to do anything about it. Do you have the faintest idea how I can go about presenting my case and getting some money to really support this particular piece of research, which I think is very vital to the security of the country?"

My own judgment, after looking over his proposal, was that he was quite correct. And this is a matter which I think we have to look at very carefully. Such a reserve fund as proposed by Mr. Dawson would certainly be of immense help in a situation like this, because it could be assigned by the President, or by the National Science Foundation, to an agency which would be most appropriate for the administration of that particular research.

My own feeling is that beyond this limitation of funds, that the Federal Government has behaved with very considerable restraint,

and with relatively little bureaucracy in trying to administer these funds. But when the funds are short and the competition is stiff, they have a heavy job of evaluation. This takes time.

Mr. MEADER. I do not want to take too much time——

Mr. FASCELL. You go right ahead.

Mr. MEADER. This might anticipate future testimony a little, but I was very much impressed by a speech given by Dr. Furnas, who I understand will be our witness tomorrow, former Assistant Secretary of Defense for Research and Development. This speech was made before the Economic Club of Detroit on October 14, 1957, and he said this:

> The high degree of autonomy and the rivalries among the Army, Navy, and Air Force lead to expensive duplications and highly undesirable complications. In my view, that organizational structure is cumbersome and obsolete for carrying out the Department of Defense research and development program.

And I want to skip a little bit, it just goes on to say that each military service carries out its own program, to where he says:

> Although I obviously have some criticism of the system, allow me to say at this point that I have the highest regard for the individuals who are enmeshed in the web. The men both military and civilian, in the Defense Establishment with whom I have had the privilege of becoming acquainted, constitute the most loyal, dedicated and hard-working group I have ever known.

Now what I am trying to ask you is whether or not your experience with Government research projects would lead you to the conclusion expressed by Dr. Furnas, that the organizational setup is cumbersome and obsolete, and perhaps the procedures are unnecessarily involved and time consuming?

Dr. BERKNER. In the field of research, Mr. Congressman, the situation is not nearly so bad as in the field of development. In the field of development and engineering, I think that anyone who has worked with the system must fully agree with Dr. Furnas in his appraisal of the situation.

Mr. MEADER. But with respect to basic research, you would say that criticism would not apply?

Dr. BERKNER. This is because there is much less likelihood of duplication. And after all, the funds of the Federal Government, the funds of the Defense Department, for example, in the field of basic research are relatively small, amounting to perhaps only $30 million total—perhaps a little more.

Mr. MEADER. Just in the Defense Department? I did not get that?

Dr. BERKNER. In the Defense Department. That is right.

Mr. MEADER. A total governmentwide of something about $250 million?

Dr. BERKNER. Someone might argue with you that the Defense Department's share was $60 million, and I would not argue whether it is $30 million or $60 million, but it is right in this ball park.

I am always reminded, as I mentioned to a subcommittee of this committee the other day that national expenditure for chewing gum is $280 million, so this gives you some measure of the size. Now Mr. Fascell accused me of trying to do away with chewing gum, but I assure you that I was not thinking of this. [Laughter.]

Mr. MEADER. There was one other comment, if I may, that I would like to ask Dr. Berkner to comment on.

Dr. Furnas also said:

> At present too many parallel, duplicate, and obsolete projects survive well into the expensive hardware stage. In industrial practice not more than 1 initial research idea out of 10 survives into the development stage. This is considered to be quite a satisfactory survival rate. In the military area, at the present time, probably 1 research item out of 2 moves on into development, very often to die years later in slow, painful, and expensive deaths. This is too high a survival rate if one is at all interested in conserving funds.

Now I would like to ask, since I assume that most of your research activities deal with the Atomic Energy Commission, would you say, Dr. Berkner, that many ideas that ought to have been shut off sooner survive into an expensive, obsolete——

Mr. FASCELL. Lingering death.

Mr. MEADER. Lingering death?

Dr. BERKNER. Surely, there is no doubt about it. This is in the field of development and engineering. In the field of atomic energy we have had much better coordination because of the close collaboration of, for example, the directors of the various laboratories who consult each other very closely.

Insofar as I know there is very little duplication in the field of atomic energy. I believe, if you will ask the question of Senator Anderson, he probably would give precisely the same reply. Because this is pretty well policed.

Mr. MEADER. You think it is better policed than in the Defense Department, from your experience?

Dr. BERKNER. Oh, yes; much better.

Mr. MEADER. I would like to ask if you have any information on the proportion of Government funds which go into so-called indirect overhead or administrative costs, rather than to the actual project itself, either in scientists' time or in the laboratory facilities that are provided?

Dr. BERKNER. This varies enormously from project to project, and to a very substantial extent is dependent upon the particular accounting practices that are used from one agency to another. On a whole, there has been a tendency on the part of the Federal Government to push the universities very hard in reducing the overhead, and yet a higher overhead allowance to the universities would have permitted them more freedom in the conduct of their research activities.

In many cases universities, in order to obtain a Government contract, have had to put out money of their own, which is really, in the long run, coming out of the pockets of their students. And this is, I think, not a good thing to do. I believe, therefore, that the Federal Government could enjoy, perhaps, a better output from their research projects by allowing a higher overhead to the universities. If I remember correctly, the National Science Foundation allows 15 percent.

Well, this is just not nearly enough.

Mr. MEADER. In other words, to the extent that you are aware of it, you have a feeling that the administrative proportion of the cost is too low, rather than too high?

Dr. BERKNER. In most research the actual cost of administration is, like in any other business, something that you can put your finger on pretty closely. If you look throughout the research labs of the country, you will find that for each productive scientist there has to

be about 3½ technicians, people who fire the furnace and mow the lawns and things like this, attached to the operation.

And this ratio of 3½ is pretty nearly exact. If, in our own operation, for example, it goes higher than this, management immediately starts inquiries to see why it is rising, whether the proportion is getting out of order. If it gets too low, it means that you are wasting money by forcing your scientists to do work technicians ought to be doing. This can be a real waste.

Mr. MEADER. Mr. Chairman, I want to thank you for permitting me to participate in this hearing, and I want to thank Dr. Berkner for his comments.

Dr. BERKNER. Thank you.

Mr. FASCELL. Are the work of technicians, in this analysis, included in administrative overhead?

Dr. BERKNER. No, sir. I was speaking generally of the ratio of what one would call creative scientists to others on the job. And this ratio is rather well fixed. You can compare this ratio, for instance, among many great laboratories.

Mr. FASCELL. But basically it gets down to what your definition of overhead is?

Dr. BERKNER. That is right. This varies from organization to organization.

Mr. POLAND. Mr. Chairman, may I ask Mr. Berkner one question?

Mr. FASCELL. Yes.

Mr. POLAND. In the establishment and operation of the apportionment system under the budget, I note that the law provides that "reserves may be established to provide for contingencies, or to effect a savings whenever savings are made possible through a change in requirements" and so forth for similar reasons.

Now, isn't it true, then, that a change in contingencies or requirements on a research project call for a scientific, and not a fiscal, judgment of the requirement for the project itself?

Dr. BERKNER. Yes, sir. I should say that the law should mention one third reason for such reserves, and that is the debt ceiling which has been the matter which has affected us most in recent times.

Mr. POLAND. It does provide for other developments subsequent to the date of appropriation, but the other developments all relate back to the effecting of savings. But if the establishment of reserves is a scientific rather than a fiscal judgment, and the director of the bureau may afterward determine that the reserves will not be required at all, by effectuating a rescission of the appropriation, is that what you meant when you made the statement that, as a matter of fundamental policy, the "fiscal and budget officers must be removed as masters of research?"

Dr. BERKNER. Yes, sir; this is the case. In some of the recent cuts which have been very disastrous to research, the cut was made on an arbitrary basis, such and such a percent, which was so large that there was no alternative on the part of the agency but to make a sweeping cancellation of the contracts. This resulted in dispersal of personnel and loss of the research activity that had been built up over several years of time, but had not yet reached its culmination.

Mr. POLAND. And you did not, by any chance, mean to suggest that the law be amended by writing in the debt ceiling proposition——

Dr. BERKNER. No, sir; I think this can all be handled by the setting up of the reserves which are proposed, the no-year money which Mr. Fascell just mentioned in stabilizing research activities so that projects are cut only after they have produced or have been evaluated.

Mr. FASCELL. In that case which you just described, actually that budget cut was a tremendous loss?

Dr. BERKNER. I would estimate probably on the order of 5 to 10 times the amount of money saved as a result of that.

Mr. FASCELL. In other words, in order to save a penny, we lost 50?

Dr. BERKNER. Perhaps not that high a ratio, but it was in that direction.

Mr. FASCELL. Mr. Lanigan.

Mr. LANIGAN. You mention the desirability of setting up, in effect, a series of national laboratories. Do you conceive that these would be placed in some central organization, or would they be contracted for by various Federal agencies on the same basis that they presently contract with laboratories and universities?

Dr. BERKNER. I would rather definitely urge that they be operated under contract for one very important reason. That is the following: It is rather difficult for a professor at a university to move from his university into the Central Government and out again. So that the freedom of movement of faculty between a national laboratory and a university, which is so essential to the present concept of the national laboratory, would be severely restricted. It would mean that he would have to go on and off civil service. There would be no way of handling his retirement. There are all sorts of things that would make it very difficult for him to move freely back and forth between the facilities of the university and of the national laboratory.

If you do it under contract, the national laboratory can be set up so that it is operated as a university itself, and then professors can move in and out on a day-to-day basis between the laboratory and the university without any problem of any kind.

Mr. LANIGAN. Well, another organizational problem is whether the contract should be made by the various Government agencies which presently make contracts, or whether there should be more centralization of the contracting power in the Government. That is, do you visualize that most of these laboratories would be under contract with the National Science Foundation, which would be somewhat expanded, and maybe divided into divisions, or would you visualize that the various military services and the Atomic Energy Commission, and the Weather Bureau, and everyone else would enter into these laboratory contracts?

Dr. BERKNER. It seems to me that different agencies might be interested in contracting for different activities. I cannot imagine taking away from the Atomic Energy Commission its authority to contract for national laboratories that are working in the Commission's general field of interest, because these laboratories represent a very important source of information to the Atomic Energy Commission in the processing of its work. Likewise, it seems to me that the Department of Defense may need certain national laboratories, or what are the equivalent of national laboratories. Here it is entirely possible that a centralization of authority within the Department of Defense, which would permit allocation of Army, Navy, and Air Force funds

into a laboratory that would act for the Department, rather than for an individual service, might be very useful.

On a whole, I think the idea of a single contract to our national laboratory is very important. Where a number of Government agencies are interested in some research activity that requires a national laboratory, one agency should hold the contract and other agencies having a direct interest should allocate funds through that contract.

Let's take meterology which we mentioned in our testimony this morning. Here you have the Department of Agriculture, the Atomic Energy Commission, certainly the Department of Commerce, with its Weather Bureau, possibly the National Science Foundation, the Department of Interior with its Geological Survey, and the Department of Health, Education, and Welfare are smog and bioclimatology, and certainly the Armed Forces, all having an intimate interest in the success of research in the field of meterology. Here I think you might well say the National Science Foundation should write a basic contract and then set up a means of collaboration within the Government for that apportionment so various departmental budgets could be made to satisfy the needs of the different departments.

Mr. LANIGAN. Well, you would agree that if the program expanded, there would be need for a stronger coordinating agency in the Government than there is at the present time, or for better coordination than there is at the present time?

Dr. BERKNER. There must be a means of coordination if you have a single contract.

Mr. LANIGAN. Now I notice that in 1954 you prepared a memorandum for one of the subcommittees of the Government Operations Committee which was examining a military research program, and you stated that in the case of strategic military research and development—which is research and development for radically new weapons—there must be established an organization independent of direct military control with access to the necessary information and with close liaison with the Armed Forces.

Do you still hold to the views that you expressed in 1954?

Dr. BERKNER. Yes, sir. More strongly than ever. I think that events have shown it would be very desirable for us to have this kind of agency.

Mr. LANIGAN. So you still back this memorandum?

Mr. BERKNER. Yes, sir.

Mr. LANIGAN. Without any change.

Now what is the place of industry in this national-laboratory picture, does it have an opportunity to utilize them, does it have an opportunity to run, operate them in the picture as you see it?

Dr. BERKNER. That is correct. In the case of the Oak Ridge, the Atomic Energy Commission has contracted with the Union Carbide & Carbon Co. to operate the national laboratory. Obviously, that laboratory is more on the applied side than the Brookhaven Laboratory which is operated by the universities. But even at Brookhaven we carry on very close collaborative work with many, many industries.

It was one of my greatest pleasures to work with the Atomic Energy Commission in the formation of this fundamental policy back in 1951, a policy which would make it possible for industry to carry on research in the national laboratories.

And this has been very successful. At the present time a very substantial number of industries are working in or with the national laboratories. Now, in dealing with these industries, under our policy we do charge them full costs, and so they pay a substantial part of the operating expenses of the laboratory. They pay the full cost.

Mr. POLAND. Does that reduce the contract obligation of the Atomic Energy Commission?

Dr. BERKNER. That income is used to reduce the contract obligation.

Mr. FASCELL. Let me see. Mr. Lanigan, may I explore a thought here?

Mr. LANIGAN. Surely.

Mr. FASCELL. Dr. Berkner, as I understand your testimony, you envision the setting up of national laboratories in those areas which are necessary, that is, determined to be necessary?

Dr. BERKNER. Where tools which are comparable to the size of the problem involved are not available or cannot be made available in the university communities.

Mr. FASCELL. Right. Now there is one thing I did not get, however, and that was who would make this determination. For example, would we set up a national laboratory for medicine?

Dr. BERKNER. You have a medical department at Brookhaven at the present time. We are building and will complete this year a nuclear reactor for use in neutron therapy.

Mr. FASCELL. What kind of therapy?

Dr. BERKNER. Neutron. The use of neutrons in treatment of certain malignancies, for example. Very effective procedure, by the way. I believe that one of your congressional committees has heard our Dr. Farr on the subject, and he has given congressional testimony on this subject before.

This is a good example of a case where a reactor that costs about a million dollars and which because of this investment requires more or less continuous operation and use in the field to justify the investment, can be operated on behalf of a number of universities that can use the neutrons. For example, one of the typical users of the neutrons in medicine is the Massachusetts General Hospital at Boston. The arrangement enables doctors and patients there to come to the laboratory in cooperation with our own medical scientists to carry on these treatments.

Mr. FASCELL. I see. Does the hospital contract with the laboratory now?

Dr. BERKNER. In this case, the laboratory provides the facilities without cost because the hospital is cooperating with the laboratory in an objective of the laboratory.

Mr. FASCELL. There would be a means whereby, let's say, an industry, as distinguished from a hospital, would contract with the laboratory?

Dr. BERKNER. That is correct. Many industries contract with the laboratory. We are one of the largest suppliers of neutrons in the world.

Mr. FASCELL. And the laboratory would be specialized in a particular field?

Dr. BERKNER. That is correct.

Mr. FASCELL. And now this gets back to my original question. Who determines the establishment of such a laboratory. I mean, it would

not just arise out of need, haphazardly? That would be a poor way to do it.

Dr. BERKNER. I believe that the reason that more laboratories to fulfill these needs have not been constructed is the fear on the part of certain Government agencies, including the National Science Foundation, that the idea of establishing these national laboratories would not be supported by the Congress. In the field of atomic energy, where clearly——

Mr. FASCELL. There is no way to find out until you try.

Dr. BERKNER. In the field of atomic energy, where the Congress had expressed its views very clearly, here the Atomic Energy Commission had no difficulty in establishing the national laboratories, and I think the results are available for everyone to see—very excellent output. But in other fields, the Government has proceeded very gingerly in suggesting this because it would be costly. But on the other hand, I think the Congress would be favorably disposed, because of the outstanding results that might be anticipated.

Mr. FASCELL. Let's compare this as against a laboratory run by a private institution on a contract with the Government. I mean, do you envision any expansion of this type of project?

Dr. BERKNER. It is unlikely that the Government would finance very large facilities with a private organization unless they had rather specific plans and came to the Government and asked that these plans be fulfilled.

Mr. FASCELL. Of course, that is not the point. The point is, should we—is this a method of getting at this problem?

Dr. BERKNER. I think this would be a good method for getting at the problem.

Mr. FASCELL. You mean even better—I did not mean it that way. Is it equal to the university method?

Dr. BERKNER. Yes, because the private institution would have some money of its own to augment the Federal funds available.

Mr. FASCELL. Let's take a for instance—and I am just shooting in the dark here because I do not know anything about it—but let's say the chemical industry, which certainly has the greatest profit value of research of anything that I can think of quickly——

Dr. BERKNER. I think this is a matter that should be explored. I think your suggestion is a good one.

Mr. FASCELL. If we set up a National Laboratory for Chemistry which was, say, contracted out to some kind of an amalgamation of all the chemical industry itself, in other words, some associated attempt at research?

Yet the industry at the present time is probably spending more on basic research and applied techniques than perhaps the other industry. In other words, they are taking it now as a business matter, and the question would then arise, would you want to transfer this over to a governmental operation?

Dr. BERKNER. One would like to think, of course, that industry could put up its own money and had sources of money to put up. One has to recognize that in many research laboratories there is no fundamental research going on because industry cannot see a profit in the immediate future, and that some fundamental research might lead to industry expansion of a kind that cannot be conceived at the present time.

I am inclined to believe, in view of the size of the budget, that the most profitable place to put your money now is either with the universities, or the support of a limited number of very badly needed national laboratories.

Mr. FASCELL. This is the point that I was getting at.

Dr. BERKNER. I would say that the Union Carbide operation at Oak Ridge has been an exemplary operation of industry operation of a national laboratory.

Mr. FASCELL. That is a direct contract with a Federal agency, in which a Federal agency pays a private contract for the operation of the Government facility?

Dr. BERKNER. That is correct.

Mr. FASCELL. And the work that is done is done with a very definite framework laid down by the Government agency?

Dr. BERKNER. I would say a very reasonable framework laid down by the Government agency. The Atomic Energy Commission has been very skillful in handling these contracts and therefore we have got——

Mr. FASCELL. In allowing them the necessary freedom of operation?

Dr. BERKNER. That is right.

Mr. LANIGAN. Do we have enough competent scientists to undertake this expanded program and operate and profitably utilize a great increase in the number of research facilities?

Dr. BERKNER. This will be a problem. I may say, however, though, that one may recover quite a number of scientists when the opportunity is available.

Mr. LANIGAN. What do you mean by that?

Dr. BERKNER. Recover them from fields that are on the borderline of science and engineering. After all, there are a great many people who have good scientific training who, for lack of support, have shifted over into other activities. Sales engineering is a good example.

Mr. LANIGAN. Well, then, you think that we are not utilizing our present scientific talent to the fullest in this country?

Dr. BERKNER. That is correct.

Mr. FASCELL. That is probably the understatement of the year.

Mr. LANIGAN. And what can be done to remedy that?

Dr. BERKNER. Help the President reorganize the Department of Defense, create more opportunities for good scientific people so that there is a general shift of more people into the basic research area—things of this sort.

Mr. LANIGAN. Some people who have testified have indicated that scientists are people who have a great desire for increasing their knowledge and the knowledge of the world, and also that they are a rather dedicated group and may not be swayed by the bread-and-butter factors to the extent that other people are.

You see, scientists have their families—and I know some who have left the field—it seems to me that maybe they are just as human as the rest of us and have the same needs, and although they do have this desire for more knowledge, they still have to have the income to lead a decent life and provide for their families.

Dr. BERKNER. The most serious pressure economically that I have seen on scientists comes when it is time to educate their children. And when it is a question of whether you can afford to send the

youngster to college or not, for almost every time the scientist at that point will break away from the field and go somewhere where he can make enough money to send his youngster to college. There is where the pinch really comes.

Mr. LANIGAN. What effect, in your experience, have you had with rising costs? We have heard about the need for more money, but there is also, we know, a general rise in the cost of living. Have you found serious increases in costs of building and operating research facilities in Brookhaven and the radio astronomy laboratory in West Virginia?

Dr. BERKNER. Yes. In the field of operations, I think you can say that the costs have gone up about the same as they have gone up throughout the whole of the engineering community. But in the field of capital construction, we have been surprised that the costs have gone up much more steeply. I felt, with real understanding, for the man who talked about his increased cost on the seaway in the St. Lawrence, because his experience is precisely like ours; namely, that the rise is not of the order of 10, 20, or 30 percent, but it tends to go very much more steeply than this. The reason that the cost of research facilities has risen so high is that they are specialized facilities. You build one of an object. It has never been built before. No one has ever tried anything like this before. No one will probably ever have need, after it is built and working, to do it again. Consequently it is hand built and labor costs are really high. Because the companies that join in manufacturing the particularly large machine themselves have no experience in handling it, there is no mass production involved, it is completely custom built, and the number of man-hours is very, very large. Here we find that the costs are pyramiding 100, 150 percent above what one might have expected a few years ago.

Mr. LANIGAN. So merely doubling the budget would not help—we would merely be keeping up with capital costs.

Dr. BERKNER. In the capital field this is true. In the capital costs.

Mr. LANIGAN. What would be a good way to measure scientific activity other than in dollars? Man-years or some other factor?

Dr. BERKNER. We measure it in terms of the number of man-years of men who are competent to do independent creative research, and who those men are is subject to the definition of a director who must do it arbitrarily.

Mr. LANIGAN. I notice in speaking of budget people, they seem to be getting criticized quite a bit in our testimony, but isn't it really the people behind the budget people who establish the basic policies on expenditures of money that are the ones who are causing the trouble? The budget people have to follow policies that are set down by someone else; don't they?

Dr. BERKNER. Well, Mr. Lanigan, I look at it this way: We are at a stage in our national development where we have run into certain troubles, so we have to sit back and reappraise the situation in which we find ourselves. And one of the things that we find is that our rules of operation under budget officers with respect to our fiscal direction of research simply do not promote the wise use of our research funds. They are not permitting us to achieve our real national destiny in the field of research.

So we are in the situation now of having to make decisions which will revise control of the budget offices over research. And if we do not do it, we simply cannot make the grade.

Mr. LANIGAN. Well, would you anticipate putting scientists in the place of budget officers, or having the budget offices having scientific assistance in evaluating programs? We are always going to have a budget office, and we are going to have money to spend.

Dr. BERKNER. Yes; but in the field of fundamental research, you have to tell your various agencies, who presumably have scientists who can judge the effect of this of research, that "We want you in the next 5 years to lower your research expenditures for research by so and so much, or to raise them by so and so much," knowing that it will require a long time, not a 1-year period, in which the desired change should take place. So that in the field of research, because of the long-time period involved in bringing to fruition, you simply have to have a "time constant" that is much longer than the budget——

Mr. FASCELL. In other words, you cannot apply a cut in the next fiscal year, you can apply it 5 years hence?

Dr. BERKNER. It costs too much to apply an arbitrary cut in the next year.

Mr. LANIGAN. We have to change our basic concepts, and possibly establish a reserve fund as you have mentioned.

Now you had had something to do with setting up the science aid program in the State Department, didn't you?

Dr. BERKNER. That is right.

Mr. LANIGAN. How was that set up?

Dr. BERKNER. There was a survey conducted jointly by the Department of State and by the National Academy of Science at the request of the Secretary of State in 1950. This study led originally to the establishment of the science adviser and the science attachés.

Mr. LANIGAN. Do you think that the science aid program could help this country in its scientific progress?

Dr. BERKNER. There is no question about it; very greatly.

Mr. LANIGAN. And you think it has done that up to now?

Dr. BERKNER. Well, of course, it was discontinued for 2 or 3 years, presumably for budget reasons, but it is back in operation again, and I anticipate that it will be very effective. It was when it was in operation before.

Mr. LANIGAN. Do you think science can be an instrument of foreign policy?

Dr. BERKNER. I would refer you back to my reading of the statement on the American Assembly, which I believe is the most authoritative of its kind, and this conclusion is that it is.

Mr. LANIGAN. Would you like to enlarge on that at all?

Dr. BERKNER. Well, failure to use it is a failure of foreign policy.

Mr. POLAND. Would you want to comment on the announcement made in the paper this morning on the interchange of scientific people between this country and the Soviet Union?

Dr. BERKNER. I think the President has made a very great step forward, and I think the step will be reflected in the next few years in a better understanding between the two countries, which may eventually provide a basis of settlement of one kind or another.

Mr. FASCELL. I adhere to the premise that all scientists are intelligent people——

Dr. BERKNER. I understand, however, that this includes more than scientists, and presumably these——

Mr. FASCELL. I like it, I will go along with it. [Laughter.]

Dr. BERKNER. Mr. Chairman, I have a 1 o'clock plane to make.

Mr. FASCELL. All right, Dr. Berkner. We appreciate very much your fine testimony before this committee, given with a frankness and clarity and keen analysis of the situation which should contribute, I hope, immeasurably to the solution of several problems.

I want to thank you very much for coming down and being with us again.

Dr. BERKNER. Thank you, Mr. Chairman.

(Whereupon, at 12:10 p. m., the subcommittee adjourned.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

WEDNESDAY, JANUARY 29, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION OF THE
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1501, New House Office Building, Hon. John W. McCormack presiding.

Present: Representatives McCormack (presiding), Fascell, Harden, Brown, and Michel.

Also present: Orville S. Poland, general counsel to the committee; James Lanigan, associate general counsel; William A. Young, staff consultant, and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK. The subcommittee will come to order.

We are honored in having before us this morning, appearing as a witness before the subcommittee, Dr. C. C. Furnas, chancellor of the University of Buffalo. We are very glad to hear from you, Doctor.

STATEMENT OF DR. C. C. FURNAS, CHANCELLOR OF THE UNIVERSITY OF BUFFALO

Dr. FURNAS. Mr. McCormack and gentlemen, my name, as you have indicated, is C. C. Furnas and I am the chief executive officer (chancellor) of the University of Buffalo. I have been requested to appear before you to express my views on the national pattern of scientific research and development.

As a bit of background, nearly all of my professional experience has involved a combination of research and development and teaching. My experience includes 5 years of research in process metallurgy with the United States Bureau of Mines, 12 years as associate professor of chemical engineering at Yale University, which post embodied substantial research activities as well as teaching, 18 months as a technical aid in the National Defense Research Committee, coordinating and supervising Government contract research during World War II, 3 years as director of research of the airplane division of the Curtiss-Wright Corp., 8 years as director and executive vice president of Cornell Aeronautical Laboratory, Inc., and 15 months as Assistant Secretary of Defense for Research and Development. Presently, as chancellor of the University of Buffalo, I head an institution which engages continuously in many and varied scientific activities,

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in addition to academic instruction. I am submitting a more complete biographical statement for the record, if you wish.

In preparation of this statement, I was furnished by your staff with 10 items for discussion. I shall take them up in that order.

ITEM I. THE RELATIVE PLACE OF THE UNITED STATES HISTORICALLY AND CURRENTLY IN THE WORLD OF SCIENTIFIC THOUGHT, ACTIVITY, AND DEVELOPMENT

That is quite a weighty subject. Our country, from its very beginning, has displayed unusual ingenuity and inventiveness in developing effective devices, processes, and materials for human use, as is evidenced by our great and effective industrial structure. However, these developments must be distinguished from purely scientific activities; science essentially being the contribution to the sum total of basic knowledge about the physical world. Historically, the development of scientific knowledge in the United States lagged behind that in Western Europe until after World War I. Prior to that time, the United States was far behind England, Germany, and even France, in scientific activity. After World War I the scientific pace quickened dramatically in this country and we were on a par with England and Germany by the late 1920's or early 1930's. This country continued to grow rapidly in scientific stature until, by the early years of World War II, we were clearly forging ahead of England, Germany, and France. Since 1940 the continuing progress has been most impressive. The quantitative trend is very revealing. For instance, the amount of money spent from all sources throughout the Nation on research and development has increased by some 7½ percent between 1940 and the present. During this same period the Federal Government expenditures for research and development have increased some thirty-five-fold—from $70 million to $2½ billion per year at the present time.

Further, in terms of results, since World War II, the United States has truly become the world leader in basic science. This is evidenced by the preponderant number of Nobel prize winners from the United States. And now I want to correct that next sentence, the third sentence of paragraph 2, for the record. Rather than the sentence there, it should be that during the last 20 years we have furnished more Nobel prize winners in the sciences than all of the countries of Western Europe combined. It should be noted and seriously weighed, however, that a large proportion of these Ameracin Nobel prize winners are men and women of foreign birth and education, who are now residents or citizens of this country. This is evidence that we are still leaning very heavily in an indirect manner on the basic knowledge and scientific talent of other nations. It is yet to be demonstrated that our educational system is adequate to maintain and expand this leadership in science during the next generation.

In contrast to the American situation, the Soviet Union, since its founding 40 years ago, has not made many important contributions to basic science. The Soviets have produced only one Nobel prize winner, Dr. N. N. Semenov, a physical chemist. Up to now, Soviet scientific contributions have had but little impact on the current scientific thought of the world. A world-famous Swiss organic chemist recently commented to a colleague of mine that one could be just as good an organic chemist if he had never heard of Russian research in the field.

American physicists seem to evaluate the Russian progress in about the same way, though they admit that Russia is making rapid progress in many areas, particularly in high energy physics. One might suspect that there is a small element of sour grapes in such evaluations but, on the whole, they are probably reasonably valid. The fields in which the Russians are having the greatest impacts are astronomy and mathematics. One might add to this list that body of investigation and observations which comes under the head of Arctic research, though one might debate whether or not this was basic science. However, Russia now has a great many scientists engaged in basic research, many of whom are very capable, energetic, sincere and thoroughly educated in their specialty. Just from the sheer mass of effort—if for no other reason—it may be expected that the Russians will show quite marked progress in basic scientific research within the next few years.

In applied research and development of devices, particularly military equipment, the Russian picture is quite different. By dint of major attention, support and hard work, they have made remarkable progress in the field of applied science, particularly during the last 10 years. This is evidenced, of course, by such things as their military aircraft and particularly and dramatically by their two satellites, Sputnik I and Sputnik II. These developments indicate that if the Russians really consider it important to carry out a difficult project in applied science and development, based on the world reservoir of fundamental scientific knowledge, they can do so effectively and expeditiously.

In order to arrive at some quantitative feeling of the relative position of this country and Soviet Russia, Dr. Raymond Ewell, vice chancellor for research at the University of Buffalo, has made the following evaluation:

As rough estimates the United States, Soviet Russia, and other countries may be doing these percentages of the world's research effort, in the following categories:

Basic research: United States, 25 percent; Soviet Russia, 10 percent; all other countries, 65 percent.

Nonmilitary applied research, including industrial, agricultural, medical and all other areas of nonmilitary applied research: United States, 50 percent; Soviet Russia, 10 percent; all other countries, 40 percent.

Military applied research: United States, 40 percent; Soviet Russia, 40 percent; all other countries, 20 percent.

"All other countries" includes a list of 18 others.

If these figures are anywhere near correct, they indicate that both the United States and Soviet Russia are depending on the smaller countries to supply a large part of the basic science needed to keep applied developments moving along.

To summarize item I, the current relative status of the United States vis-a-vis Soviet Russia, I would like to make the following points:

1. In basic research Russia is behind the United States but it is moving up rapidly.

2. In nonmilitary applied research and development Russia is now far behind the United States, but is undoubtedly making substantial progress and could speed up very rapidly if it became national policy to do so.

3. In military applied research and development, the Soviets are breathing down our necks.

4. Because of the rapidly accelerating pace of the Russians, unless the United States moves at a faster pace in both basic and applied

science in the next 10 years, we will probably by that time find ourselves behind the parade. This could be a national tragedy.

I feel a better summary of the situation has been given by Dr. Lee DuBridge, president of the California Institute of Technology, as reported in a recent issue of Life (December 16, 1957, p. 109) as follows:

> The Russians were in the position after World War II that we were, in the 1920's. They woke up and they've been going like mad. Whenever that happens you'll find progress is greater in some directions than in others * * *. It's not like a race between 2 horses but more like a race between 2 fleets of 100 yachts. Some of their yachts are ahead and some are 'way back. But their whole fleet is moving faster, and all their yachts could move ahead.

Item II of the outline was a comparison of the budgets and budgetary procedures for scientific research in the United States, Russia, and other leading nations.

I have no information on budget procedures in Russia or other countries which is sufficiently firm and complete to make any observations on that point. Neither do I have at hand any data on research and development expenditures in other countries, except for one piece of information about the Russian budget.

I recall seeing a Soviet research budget figure of 50 billion rubles for the current year. At the generally accepted tourist rate of exchange of 10 to 1—this is probably more realistic than the official rate—this is equivalent to $5 billion. However, in terms of human employment, 10 billion rubles in Russia undoubtedly goes a lot further than $1 billion in the United States since, on the average, salaries are much lower in Russia. It would appear, then, that the Russian scientific effort in terms of manpower applied is probably at least as great, and probably greater, than in the United States. Since the Russians undoubtedly put a large proportion of their effort into direct military application, it is probably safe to say that the Russian effort in applied research and development for military purposes is at least equal to and probably substantially more than in the United States at the present time.

ITEM III. A SUMMARY OF THE RELATIVE POSITIONS OF THE UNITED STATES FREE WORLD AND THE COMMUNIST WORLD WITH RESPECT TO SCIENTIFIC EDUCATION AND MANPOWER

Again I am indebted to Dr. Raymond Ewell, the vice chancelor for research at the University of Buffalo, for research on this question. He has made the following analysis:

Relative Positions in Scientific Education and Manpower

The actual number of trained scientists and engineers on duty at the present time is much higher in the United States than in Russia—about 900,000 scientists and engineers in the United States; probably not over 500,000 in Russia. However, Russia is producing engineers at a much higher rate than the United States, although the United States is currently producing more scientists than Russia. Figures are estimated as follows:

Scientists at the present time, and this is the annual production at Bachelor of Science level in 1956: United States, 24,000; Russia, 15,000.

Engineers, United States 25,000; Russia, 75,000.

So in the overall scientists and engineers at this tremendous rate of production, we are about 49,000 as against 90,000 per year in Russia.

I have no accurate data at hand on countries other than the United States and Russia.

This is probably an appropriate place to gaze into the crystal ball and estimate America's future needs of scientists and engineers if the Nation is to maintain its economic and military status.

In 1955 Dr. Ewell prepared a report on this subject for the Manufacturing Chemists Association. The report as follows is reported from Dr. Ewell:

> The definitions of "needed technical labor force" for any given year is a tenuous and complex problem. Probably the most straightforward way to look at it is in terms of how many scientists and engineers will be needed to continue the Nation's past economic growth and to maintain an adequate national defense. Since there is no quantitative measure of national defense, we have based our projections entirely upon economic growth. During the past 30 years the average growth rate of the United States economy has been about 3 percent per year, whereas, the growth rate of the number of scientists and engineers (technical labor force) has been about 6 percent per year. During the past 10 years (1946–55) the economic growth rate has been about 4 percent per year. Therefore, we have assumed that a growth rate of 6 percent per year in the technical labor force would be needed to continue an economic growth rate of 4 percent per year during the period 1956–65.

On the above basis, Dr. Ewell, from the vantage point of the year 1955, estimated that in the present year, 1958, America would have a shortage of 135,000 scientists and engineers for the adequate maintenance of our economic and military posture. The deficit by the year 1965 is estimated to be 457,000.

One might have differences of opinion of the actual numbers involved but it seems to me that the direction of the trend of need is indisputable, provided America is to maintain an adequate economic and military status during the next decade.

It must be emphasized that it is not sufficient just to produce a certain number of scientists and engineers. There must also be adequate support from industry, private sources, and Government for their continuing professional activities, or the necessary results will not be accomplished. Further, we must realize that numbers alone do not solve the problem. The most careful attention must be given to the quality of the scientists and engineers which our educational system produces. Discussions on this point are always long and involved and I do not feel that it is appropriate to delve into that aspect here.

ITEM IV. SCIENTIFIC FIELDS IN WHICH THE UNITED STATES HAS LAGGED AND IN WHICH IT HAS FORGED AHEAD AND THE EFFECT OF THE ACTIVITIES AND POLICIES OF THE FEDERAL GOVERNMENT IN SUCH CASES

The United States is quite active at the present time in all scientific fields and I do not know of any in which we are lagging behind seriously at the moment. It is most important to remember that we are trying to predict the future and that if we just maintain the status quo we may be seriously lagging in some areas within the next 10 years.

If one begins enumerating the fields in which we have forged ahead, he is probably laying himself open to argument but I would suggest that in the general areas of nuclear science and the medical sciences we are well in the lead.

The activities and policies of the Federal Government, particularly during the past 15 years, has had a profound effect upon our scientific progress and current status. If, during this period, the Federal Gov-

ernment had not given major financial support in the civilian and military areas, we would already be hopelessly behind in the military stature and would probably be losing ground rapidly in the industrial field. I feel that it is no overstatement to say that the Federal policies and physical support of scientific activities during the past decade and a half have saved the Nation, up to this point.

ITEM V. THE PROPER PLACE OF GOVERNMENT IN SCIENTIFIC RESEARCH AND DEVELOPMENT. IS GOVERNMENT SUPPORT NECESSARY IF THE UNITED STATES IS TO KEEP PACE IN THE WORLD OF SCIENCE?

I should like to speak to the second point first. Broadly speaking, in view of the present sociological trends, it is necessary and inevitable that major Federal Government support must be maintained and enlarged if this country is to keep pace in the world. At the present time the Government is supporting roughly one-half the research and development activities in the country. If we are adequately to meet the task, I see no way of avoiding substantially increased expenditures.

Speaking to the first point of this item, it should be observed that America has grown great with a pattern of multiple approaches and a competitive pattern among industrial and governmental forces. This is a structure of great strength in a democratic society and should, by no means, be abandoned. If this observation is correct, it means that though the Federal Government must continue to be a major supporter of scientific activities, it should not assume the responsibility for detailed direction and operation in a great monolithic structure. Our present multilateral approach through Government laboratories, industrial laboratories, universities and research institutes is a very good one. It must be maintained, no matter what the source of financial support.

ITEM VI. MAJOR AREAS OF DEFICIENCY IN FEDERAL BUDGETARY PROCEDURES AND IN FEDERAL EXPENDITURES FOR SCIENTIFIC RESEARCH AND DEVELOPMENT

This is an item on which it is much easier to criticize than to offer constructive suggestions. From its very size, and necessary complication of organization, the Federal Government procedures in research and development are necessarily ponderous and slow moving. I will not attempt any detailed analysis, but there are two deleterious effects which I do believe deserve earnest attention. First, in many cases there is an inadequate assurance of continuity of support for building up a good research team and keeping it working effectively. The year-end blues, when assurance cannot be given of the next year's support, is well known to universities and other research organizations. These stop-and-go operations greatly detract from the effectiveness of a research program and add substantially to the time required and ultimate cost of projects. A research program of any consequence needs at least a 3-to-5-year lease on life, if it is to be fruitful. Of course, there always needs to be the provision for termination of unsatisfactory work or of activities that are obviously going up blind alleys. However, if the projects and the personnel are well evaluated

when a program is initiated, such terminations should be very much the exception, rather than the rule.

The second area where improvement can be made is in the evaluation of new research ideas which should receive support. In many cases, support for some very good new ideas does not come through because they are eliminated in the formulation of departmental budget requests. Nearly always the first budget estimates from any Federal bureau or department have to be trimmed below the amount which working level first asks for. In this squeezing operation, those items which are nebulous and unproven, and which might take a long time to work out, are usually at the bottom of the list and are the victims of the contraction. Thus, many good ideas and new lines of research are lost. It might be contended that the selection of projects for support is entirely the responsibility of the head of a bureau or a department and, hence, Congress is not in a position to evaluate the merits of program items which did not survive the budgetmaking operation. However, might it not be fruitful for congressional committees to review the program items which were eliminated as well as those which survive? This might give better perspective on what the program needs are and thus give a more firm basis for matching dollars against needs.

The second part of this item deals with the deficiencies in Federal expenditures for scientific research and development. For the long pull, I feel that a larger proportion of the budget than at present should be expended on what I choose to call background research and development. By background research and development I mean not only basic research but also applied research and early development on certain components of various systems which are not needed immediately, but which undoubtedly will be called for in the future, and this is particularly true, I think, for military developments. I will speak further to this point under the next heading.

ITEM VII. THE EFFICIENCY AND UTILITY OF THE ORGANIZATIONAL STRUCTURE THROUGH WHICH THE FEDERAL GOVERNMENT PLANS AND CONDUCTS ITS RESEARCH AND DEVELOPMENT ACTIVITIES, INCLUDING A DESCRIPTION OF THE MAJOR ACTIVITIES, THE AGENCIES WHICH ARE INVOLVED AND THE IMMEDIATE RELATIONSHIPS AMONG THEM

I do not feel that I am qualified to speak to this point, except for the area in which the Department of Defense is involved. Here again, in making observations, one must keep in mind the immense size and complexity of the Federal operations. This is particularly true of the Department of Defense. First, there is the duality of military and civilian control which is in the true American tradition and which has demonstrated its basic virtue many times. In addition, however, in the Department of Defense, there is the triality of the three military departments, each of which has a high degree of autonomy. Each of them is assigned the responsibility for developing its new weapons as well as using them in the event of war. This complex organization leads to duplications of effort, and often conflicts. In my opinion the present organization is obsolete for the research and development function and needs at least a certain amount of streamlining.

Since there are many suggestions from all quarters at the present time for reorganizing the Department of Defense, it might seem fruitless to add further to the list. But, I do have three suggestions which

would represent small evolutionary steps which might be worthy of some consideration. In making these suggestions, I am drawing on some analogies to the research-and-development organizations in large corporations. The organizational patterns which apply there are not necessarily valid for the Department of Defense, but there may be some meritorious features. Large corporations which are made up of a central office and several operating divisions with substantial degrees of autonomy, usually—not always but usually—have a vice president of research (or vice president of research and development). This executive usually has a central laboratory under his line authority which operates on background research and development. He also has the staff, or guidance, function of the research and development activities which are carried on in the various autonomous divisions. Carrying the analogy over to the Department of Defense, I would say that the Assistant Secretary of Defense for Research and Engineering should have some measure of positive control, including the necessary dollars, of a central background research and development program. He should have the staff or guidance function for the three autonomous divisions, that is, the Army, Navy, and Air Force, to a greater extent than he has now.

With these thoughts in mind, my three suggestions follow. These are excerpted from a talk I gave on the subject What is Necessary to Maintain our Leadership in Scientific Research, Industrial Production and National Defense before the Economic Club of Detroit on October 14, 1957.

My first point is a little beside that line of thought and deals with strengthening the research and development structure within two of the departments, themselves. My words on this point were as follows:

> There should be legislation authorizing the establishment of the post of Assistant Secretary for Research and Development in both the Navy and the Army. The Air Force already has such a post but the other services do not. This move would help to centralize authority and give appropriate stature to the activity in those two services. Such legislation was introduced in 1956 but it was defeated. It is important that Congress take another and objective look at the situation.

Mr. McCormack. Doctor, do you mind if we ask questions now?

Dr. Furnas. Not at all.

Mr. McCormack. In connection with that, there was legislation introduced. I know I introduced legislation providing for that back 5 years ago at hearings and the Department of Defense opposed it.

Of course the Air Force has it. We gave them additional assistants, but the Air Force did make one of them Assistant Secretary for Research and Development. However, the other two services did not do it. They hung them in with some other activity.

Dr. Furnas. That is right, and if I remember correctly there was a bill introduced in 1956 and it was defeated. I have forgotten all the ramifications of the argument at that time. Mr. Wilson, at that time Secretary of Defense, supported this legislation. The Army and the Navy were not very enthusiastic about it, but they were willing to go along. However, it was defeated and then the following year, 1957, Mr. Wilson seemed to have lost his enthusiasm for it. So far as I know, nothing further was introduced. I am suggesting this is a good thing to do and such legislation should be introduced again.

Mr. LANIGAN. Was there any consideration in the Department to setting these assistant secretaryships up administratively rather than going through legislation?

Dr. FURNAS. If I remember correctly, the General Counsel investigated and decided there would have to be legislation in order to set them up, and this was the reason for introducing the legislation. But that is not a point on which I speak authoritatively. As I understand it, legislation was considered to be necessary.

Mr. POLAND. In your suggestion, Dr. Furnas, how would you prevent a project dropping out somewhere between the line function and the staff function?

Dr. FURNAS. This simply means that you will have a person with recognized authority and stature so that you will have an individual in each of the departments, an Assistant Secretary of Research and Development, to work directly with, but as it is now, without these two people in the authoritative position, it tends to be a little more nebulous organization and a little more difficult to work with.

Mr. POLAND. You are not afraid under this plan that some of the research work would be lost between no man's land and the actual operation?

Dr. FURNAS. We always do that. I think that has been recognized.

Mr. MICHEL. One question, if I might: Would you propose, then, with this additional Assistant Secretary, that the three of them get together periodically, similar to the Joint Chiefs of Staff, so there would be complete coordination of their activities?

Dr. FURNAS. Yes. There should be more than there is. The rather informal organization which was called the Research and Development Policy Council, which consisted of those who were responsible in the civilian and also the uniform of the three services, would then meet with the Assistant Secretary of Research and Development. An informal group is very helpful in the coordination.

My second point deals with giving more positive control of the Assistant Secretary for Research and Engineering over the research programs as a whole.

A certain proportion—say 10 percent—of the research and development budget of all the three services should be set aside for background research and development and placed under the jurisdiction of the Assistant Secretary of Defense for Research and Engineering. This would then give this Assistant Secretary the opportunity for some positive control in guiding the military research and development program. At the present, he has only negative control because his office has no research and development funds. He can say "no" to a program but he cannot initiate any positive action. That, I submit, is a poor way to run a railroad—or a research and development program. If such funds were under his jurisdiction, the Assistant Secretary could use them for work contracted for by his office or he might allocate them for approved projects for background research and development to the individual services. This would give him a modicum of constructive control of the program.

I recognize that this suggestion, to be effective, would call for some changes in the point of view of the role of the office of the Secretary of Defense. It might even call for some legislation redefining the role of the Office of the Secretary of Defense, and of the individual services. But, whatever legislation may be required, I submit this as a suggestion which is worthy of investigation.

My third suggestion is a little more complicated as it involves the mechanism of the approval of initiation, or continuation, of projects

within the structure of the office of the Secretary of Defense. My thoughts on this were represented as follows:

The above two steps might help substantially in giving background research and development appropriate status and effectiveness. But such activities—this is the background work—actually only consume a small percentage of the dollars. The really large expenditures come in the late development and adaptation phases. Closer control in this area is required, if the funds are to be spent effectively. At present too many parallel, duplicate, and obsolete projects survive well into the expensive hardware stage. In industrial practice not more than 1 initial research idea out of 10 survives into the development stage. This is considered to be a quite satisfactory survival rate. In the military area at the present time, probably 1 research idea out of 2 moves on into development, very often to die years later a slow, painful, and expensive death. This is too high a survival rate if one is at all interested in conserving funds and effort.

I am a believer in a minimum birth control of new research projects but also a substantial amount of early infanticide of projects before serious development is undertaken. Because of the multiservice complexities, the Department of Defense does not have any really effective control at this point.

In my opinion, an effective administrative mechanism could be established in the Office of the Secretary of Defense to handle this situation. At the present time some $3½ billion of production funds are being spent for the late development or adaptation phase, as I call it (in addition to the $1.6 billion on research and development. A directive could be instituted requiring the seal "Approved for development" before any production funds would be considered for expenditure on a project of any service. This approval would call for the signatures of both the Secretary of Defense and the Assistant Secretary of Defense for Research and Engineering. This would provide a modest barrier and check point and would afford opportunity for objective consideration and evaluation before the use of production funds entered into the budget planning of the individual services. This, in my opinion, would represent a substantial improvement over the present practice.

ITEM VIII SUGGESTIONS REGARDING ORGANIZATIONAL AREAS MERITING STUDY BY THE COMMITTEE

I believe that I have made all of the suggestions on which I feel myself at all qualified to speak under item VII above. If, as a result of various considerations and deliberations, there should be in the near future major and basic changes in the organization of the Department of Defense, the organizational structure for the handling of research and development should be reexplored. But I do not feel that it would be timely to discuss that aspect in terms of some hypothetical major change.

I would like to make two comments—1 positive and 1 negative—on the overall organizational structure of the Federal research and development program. First, I feel that the President's appointment of a scientific adviser reporting directly to him was a very wise move and that in the naming of Dr. James Killian to fill the post, he selected the best possible man. My negative point is that the suggestion for the establishment of a Secretary of Research, or some similar title, of Cabinet rank does not appear to me to be justified or sensible. I feel that it would simply be adding another office to an already overly complicated structure and would be a hindrance rather than a help.

Mr. McCormack. Doctor, do you mind as we go along if we ask questions?

Dr. Furnas. Not at all.

Mr. McCormack. I think it is universally agreed as to what you said about Dr. Killian being an outstanding man and one of the great

administrators in this field. There are very few top administrators; is that right?

Dr. FURNAS. That is correct.

Mr. MCCORMACK. They are a select group and it is very difficult to bring about a manageability and workability between the different groups that are involved that make up a team; is that correct?

Dr. FURNAS. I feel that is correct; yes, sir.

Mr. MCCORMACK. Have you any idea what authority and responsibility Dr. Killian has?

Dr. FURNAS. All I know on that is what I read in the papers. As I understand, it is purely an advisory capacity, and I believe that that was the intent and that that is the way it is functioning. But, of course, he is a very influential adviser.

Mr. MCCORMACK. If backed up.

Dr. FURNAS. If backed up; yes. But, as I understand, the assignment does not have any line authority at all.

Mr. MCCORMACK. On the operating level, it is the Defense Department.

Dr. FURNAS. Of course his position isn't entirely for defense. Presumably he will be advising on all scientific matters, but they are primarily for the Department of Defense because that is of prime importance.

Mr. MCCORMACK. What do you think of an agency or council—call it any name you want to—appointed by the President and confirmed by the Senate, on the level directly under the President, with direct access to him and responsible to the President, with the power to make decisions and the authority to carry them out?

Dr. FURNACE. I feel that the present setup, particularly when you have a man of Dr. Killian's capability, is probably quite satisfactory. He is now Chairman of the Committee which was formerly reporting to the Office of Defense Mobilization, which was the so-called Rabi Committee, and previous to that Dr. DuBridge was chairman. This has now the same Committee members, but Dr. Killian is acting as Chairman of that Committee, so he is getting advice and guidance of these top scientists throughout the country. This, I think, is serving essentially that function.

Mr. MCCORMACK. I think there wouldn't be much argument with your observation. Of course again it is a question of what authority Dr. Killian has and then what support he has. You, of course, recognize, being a Presidential appointment is at the will of the President; it is not statutory; that is, it has no statutory authority. There is authority to appoint him, but I mean there is nothing of a permanent nature in connection with getting reassigned.

You see, this committee has been through this before in 1954. We explored it for many months. You are well aware of that.

Dr. FURNAS. I am; yes, sir.

Mr. MCCORMACK. You probably read the testimony and the report of the subcommittee under the very distinguished American and Member of Congress, Mr. Riehlman, from New York. I sat in on that committee at the time, during all of the hearings, because he and I collaborated before he had his subcommittee go into that important field, and we found little clashes of personality, which are human, different characteristics of the scientists and the military—basic scientists, in particular—but basic as well as applied are very in-

dividualistic individuals and, of course, your military have to center their thoughts around obedience and discipline, which are necessary, but those are some of the factors and they were many, many fold and they still exist there in the human mind.

Now I was wondering what your views would be. You have said you don't like a Cabinet status. Well, without closing my mind to it, I am inclined to feel the same way that you do, just frankly exchanging views now. We read about a czar. Well, of course, that is just a characterization, but it means one man to have the complete authority and that is rather drastic in a democracy and, furthermore, suppose he is wrong on a question that might involve the very life of our Nation. A small group of superior men, with their knowledge and experience and education and wisdom, they all contribute to a collective thought and action so it doesn't go off in the wrong direction. But we know that in research and development, some of it dies, being on a low level and trying to get through so many hands and so many stumbling blocks arise. This is not criticism, because it is not in regard to any one administration. It is well-recognized it has not been able to assert itself with the potency that is for the best interest of our country, and some have thought of recognizing the importance of having a council like the National Security Council—of course that is risky—but giving it power to make decisions and the authority to carry them out. Of course in cooperation with the military, something of that nature has to be done because if you don't have a Cabinet and you don't have a czar you have to have something else.

Now your suggestion is as to the Assistant Secretaries. I can see the potency of them but, on the other hand, I can see the stumbling blocks arising.

Dr. FURNAS. Yes, sir.

Mr. MCCORMACK. What would be your views, generally speaking, without committing yourself?

Dr. FURNAS. Well, it is purely my personal view, but I do feel that a national overall authoritative council or officer is not the way to approach research and development because the field is so complicated, it is so widespread, and I think it would simply lead to more entanglements.

Mr. MCCORMACK. This is military, of course.

Dr. FURNAS. No, I am speaking of the national picture as a whole.

Mr. MCCORMACK. I am thinking about the military, essentially military research.

Dr. FURNAS. If you are speaking of military, I do feel in this case that probably the research and development should be centered with more authority in one office, the appropriate part of the Office of the Secretary of Defense, and I would suggest it should be at the Deputy Secretary level or Under Secretary level. In other words, there should be one man in the Office of the Secretary of Defense, with whatever staff is necessary, who would be responsible for the future. He would be the Deputy Secretary for the future of military requirements and all of the things that go into that. I think he should have more authority than the Assistant Secretary of Defense for Research and Engineering now has.

Now, then, one thing which is a little bit disturbing to me at the present time is the tendency to set up splinter groups. Call them vertical splinter groups. And this is where the call for the czars comes from.

For instance, when the Special Assistant for Guided Missiles, the

post now held by Mr. Holaday, was set up, formerly held by Mr. Eger Murphy, I felt that that was a good move because as an emergency operation you did need to pull together the activity, particularly in the ballistic missile field. I felt, however, that this should be on a temporary setup. By temporary, I don't know whether I was speaking of 1 year or 5 years, but at least not a permanent setup. Mr. Wilson and I discussed it several times and I know it was his idea that this was essentially an emergency operation to get the thing on the track, and then that office should eventually be dissolved and go back into the regular organizational structure.

Now we have discussion coming up at the present time: Let us set up another vertical group, the Advanced Research Projects Agency. I recognize the merits of the argument that we need to do something in a hurry but, on the other hand, you are setting up another vertical group which is, essentially, taking personnel and authority from the Office of Assistant Secretary for Research and Engineering. You are really taking the sap out of the central research and development organization of the Department of Defense.

Now, then, if you had the officer who was responsible in the overall sense for the research and development of the Department of Defense at the deputy level, he could bring together these different types of splinter organizations, whenever you need them for emergency operation, and will have more control. So, to answer your question briefly, I do feel that the rank of the person or the office which is responsible for the military research and development should be the higher level than it is now and he should be given the responsibility and authority to pull together these multitudinous operations throughout the whole Department of Defense and the various services—at least more authority than he has at the present time.

Mr. McCormack. Is Mr. Quarles supposed to operate in that position?

Dr. Furnas. He is deputy, which, of course, means going across the board. What I am suggesting is it might not be feasible to have two deputies because that has the connotation of being the alter ego, but there might be an Under Secretary, which is essentially the same rank, and he would devote his whole time to research and development. Mr. Quarles, in his deputy post, has at least 15 other things he has to do.

Mr. McCormack. What inducements are there for officers in our various branches to devote their career to the field of research and development? In connection with future advancement of rank, what inducements do the officers have in that connection, that being a natural feeling for any young officer to entertain?

Dr. Furnas. Are you speaking of the military services?

Mr. McCormack. Yes.

Dr. Furnas. The man in uniform, you mean?

Mr. McCormack. Well, it would be the officer; the men in uniform, yes.

Dr. Furnas. I feel, in general, the research and development activity should provide more possibility for advancement in the services than is true at the present time.

Mr. McCormack. Don't you think it should be a career for a man instead of a 2-year assignment or 3 years?

Dr. FURNAS. Very much so, yes. You see the trouble, for instance, in the classification of engineering duty only in the Navy. Ordinarily an officer with that assignment doesn't rise above captain. Now I don't know that there is any legal restriction on this, but this is simply the custom. In the Army and the Air Force, I think ordinarily those who are in research and development, who have spent their career at that, do not have the opportunity of rising to top positions. This simply seems to be part of the mores of the service and I feel that this is deleterious to inducing capable people in research and development to make a career of the services.

Now there are not going to be very many rise, really, to the top, but the fact that there is no block there makes a tremendous difference in motivation for a good research and development man. I think the situation is analogous to a corporation. If there were a custom or a rule that an engineer could never possibly be president of the company it would be deleterious to the motivation of engineers. Not that I am saying that the president of the company should always be an engineer, but I think that the opportunity of being a president of the company should be open to engineers and I think if corporations had a policy to the effect that no one from the technical ranks could ever be president, it would be very disturbing to a number of people. I think this is essentially the situation at the present time in the military services—that those who devote their whole career to the research and development end have probably a very small chance that they are going to be considered for the top ranks.

Mr. MCCORMACK. We have divisions within the armed services, like in the Army the Corps of Engineers, and we have the Ordnance and Transportation.

Dr. FURNAS. Yes.

Mr. MCCORMACK. Why shouldn't there be a division of technology—call it any name you want to—because it isn't a question of meeting the top rank alone; there are many people in the Army and Navy that don't meet the top rank, but they become generals and admirals in the various grades. They want the opportunity to go ahead and that is only natural because they have their problems; they have families and their economic problems and their ambitions and they don't like to get thrown into a service activity where the number of positions in higher ranks are very, very limited in proportion to other services.

Do you get my point—something to induce them into this field? We ran into this in 1954 and it has never left my mind. Of course, we ran into many other things, but I could see myself, if I were in the Army or Navy and a young man starting out to make a career, naturally I would want to go ahead if I merited it and if I get into a branch of the service where I am frozen, where the number of general officers, for example, in the higher rank—colonel and general officers are small in proportion to other services—it would only be natural for me to try to get in the branch of service where the opportunity to get ahead is greater. It certainly wouldn't be contrary to human thought and intention to do so.

Dr. FURNAS. I certainly concur with you, Mr. McCormack, on this, the necessity for motivation, and my principal point is I feel that there should be equal opportunity, no artificial barriers, by custom or otherwise, to the man who is making a career in research and development of getting to the very top opportunities to advance, of

course, step by step. There are only a very few going to get to the top, but still it is highly important in motivation to have that opportunity so they will not be excluded.

Mr. McCormack. Coming back to Dr. Killian, we don't know completely what the authority is, but if he is kept strictly in an advisory capacity, I think the possible use, in my mind, will be sharply minimized. Do you have any observations to make on that?

Dr. Furnas. This depends, as you pointed out, on what support he gets. If he gets the support, he will have a great deal of influence; if he doesn't get the support, he won't have any.

Mr. McCormack. That means Presidential support?

Dr. Furnas. That is correct, or whatever other channels there may be, backed, of course, by Presidential authority whenever necessary. The point is if you would take the post of Dr. Killian, and make the incumbent responsible for a line organization of some kind, whether you call him a czar or not, then you are going to, in my opinion, ruin his effectiveness as an advisor because as soon as you get into one of these complicated activities which are going to be involved in any of these line organizations, particularly if it is controversial, you are just not going to get anything else done. I don't think you can do both, and I think that this matter of having the best possible scientific advice and guidance to the President is very important, but I would really rather fear the loss of effectiveness if Dr. Killian were given some line responsibility for a major activity in research and development.

Mr. McCormack. But you admit somebody should be?

Dr. Furnas. No, sir, I don't believe I did.

Mr. McCormack. You said in the defense level.

Dr. Furnas. The defense level, but I am talking now about the Presidential level.

Mr. McCormack. If you were Secretary of Defense, would you want to see authority given to an under secretary or assistant secretary that makes him autonomous and independent of your direction and responsibility as Secretary of Defense?

Dr. Furnas. Well, sir——

Mr. McCormack. I am just inquiring now.

Dr. Furnas. Yes, sir. I would, of course, with the proviso that the Secretary would always have the ultimate authority.

Mr. McCormack. But he has that anyway. He should have it under law.

Dr. Furnas. He has it, yes. I am saying with that proviso I would like to see a deputy who had a high level of authority in research and development and be able to carry it out rather than simply be in the staff function.

Mr. McCormack. All right.

Did you want to ask a question?

Mr. Fascell. Yes, sir, Mr. Chairman.

Under the present concept the Assistant Secretary for Research and Development is clothed with the full powers of the Secretary of Defense. Is that your understanding?

Dr. Furnas. No, it isn't, except as it may be particularly delegated to him.

Mr. FASCELL. Well, in other words he would only have those powers which are particularly delegated to him in the research and development field by the Secretary?

Dr. FURNAS. Essentially, his function is that of a staff function, rather than a line responsibility.

Mr. FASCELL. What difference does it make what his authorities and powers are if he can't do anything except what the three services will agree upon anyway?

Dr. FURNAS. Well, this is a very good question. That is the point; I think that he must have the authority and this means, in my opinion, he must have control over some funds for the background of research and development.

Mr. FASCELL. This is the problem you ran into when you were a research and development man, wasn't it—essentially?

Dr. FURNAS. One of the problems, yes.

Mr. FASCELL. Thank you for correcting me. You had plenty of them.

Mr. MCCORMACK. All right, Doctor.

ITEM IX. THE RELATIVE EFFICIENCY AND ECONOMY INVOLVED IN CONDUCTING SCIENTIFIC RESEARCH AND DEVELOPMENT THROUGH GOVERNMENT FACILITIES, UNIVERSITIES, OTHER NONPROFIT ORGANIZATIONS AND PRIVATE CONTRACTORS

Dr. FURNAS. Each of the types of organizations mentioned in the title serves a vital and necessary function in the research and development pattern of the Nation and their identities and vigor must be maintained. There are widely varying opinions as to exactly what role each type of organization should play, and also as to what proportion of the total available support should go to each. Naturally, the various opinions are conditioned to a substantial degree by the frame of reference from which an individual speaks, or of the type of organization with which he is associated. Probably it is asking too much of human nature to expect a person speaking on a controversial issue such as this to be completely objective, without any shred of prejudice. Bearing this in mind, I will be as objective as I can and make a few comments on each type of organization.

Allow me to say in general, however, that it is not realistic to try to make comparisons of efficiency and economy on the basis of dollar expenditures alone. The roles of the different types of organizations are different and there are wide variations in attitudes and approaches. So, there is very little basis for making dollar comparisons of their operations. The various types of activity are complementary to each other and it would be adding apples and oranges to try to make comparisons on a cost basis alone.

I am of the opinion that at the present time there is a rather unbalanced emphasis upon the governmental establishments. This is not meant to be disparaging in any way on the fine work which many of the governmental laboratories do. There are certain areas, in aviation and in agriculture for instance, in which the appropriate activities can only be carried on by a Federal agency of national scope. It is also true that there is a degree of continuity and permanence in Federal laboratories that is not obtainable in some other types of institutions. Again, just as the chief executive officer for research in

a large corporation needs an organization where he can promote and carry on constructive programs, so major departments of Government need some of the same type of facilities.

The various governmental laboratories vary greatly in their effectiveness and performance. When a new one is established, it usually starts out with considerable verve and enthusiasm and this holds as long as there is an insistent motivation for a new line of work. However, I think that we must face the fact that after a period of time, unless there is some restoring factor, the cloying effects of various aspects of bureaucracy do tend to bog down the operation. There are a number of notable exceptions. Many of the country's outstanding scientists are working, and fruitfully, in governmental laboratories. Some of the laboratories and arsenals have had outstanding results in both research and development, with great national benefit. I am speaking, however, of what seems to be the long-time trend and probably the average situation.

There is another aspect to Government laboratories. After they are well established with an air of permanence, they tend to take an increasing amount of the budget which is available for research and development. No matter what may be the strength of the present wave of support of research and development, it is almost inevitable that there will be ups and downs in the national picture. If there are a great many large governmental laboratories and if there is a serious budget squeeze, there is a natural tendency to give them first consideration for the limited number of dollars. This has an indirect, but very serious effect upon the possible support that is available for universities, nonprofit research institutions and for industrial contracts. This can, and I think in some cases in the recent past, has weakened the entire national program.

During and since World War II, a number of very strong, nonprofit research institutes and laboratories have arisen which have a unique function, not only in basic research, but in carrying on through the applied phases of programs which are of great interest and value to the Department of Defense and other branches of the Federal Government. Some of them are rather closely associated with universities, some are not. They are all characterized by being self-sustaining financially and having basic and applied research as their principal objective and motivating factor. Much of the best basic information and the source of new ideas that continue through the applied research phase have come from these laboratories during the past 10 years. In general, their operation is very economical. Even more important is the fact that they are a dynamic source of new ideas and new approaches which probably cannot be found in the other types of institutions. I think it is necessary in the national scene to keep these laboratories strong and active.

Turning now to industry, I have observed a recent tendency for the various industrial companies to make very strong presentations to the effect that complete responsibility for new defense projects, even including the research phase, should be turned over to them. The general attitude is, "Tell us what you want, give us support and we will carry the load from the initial idea on to the finished hardware." I feel that it would be most undesirable to allow this trend to grow much further. There are three reasons for this. First, if industry

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takes over more and more of the complete responsibility, it will inevitably use more of the available funds. This will tend to reduce the amount of support available for the other types of institutions which are highly important in the national balance.

Second, if one could make valid dollar comparisons for the operations of different types of laboratories, I think he would find that the cost per unit of accomplishment in the basic and applied research phases would be much greater in a large industrial organization than in another type of research institution. This is partly due to the size of the major industrial organizations. Such industries usually have large engineering staffs which they naturally tend to put on the program early in the game. This leads to the overengineering of a project long before it is ready for it. There is a tendency to load up an elephant gun to shoot a fly. This can be quite expensive and even a little bit messy.

The third point is perhaps the most important. Large industries, to be successful, necessarily must set up line organizations with fairly rigid control and direction. Even though some of them have excellent laboratories, with a substantial amount of research freedom, the pattern of ideas naturally tends to be restricted to those which have a reasonable possibility of future production and profit to the company. This is nothing against the industries; it is merely their natural way of fulfilling their purpose in life. The type of apparatus that they develop for weapons systems naturally tends to be that in which the company is competent and which has some production potential. Thus, there is inadvertently a restriction on thinking and exploration, which, though somewhat nebulous, is very real. I feel strongly that the industry should have intellectual competition and inputs from other research sources. Otherwise many of the more difficult programs will tend to stultify and become moribund.

Universities have a unique value and strength in the research pattern which must, by all means, be maintained and be strengthened if we are to fulfill our national obligation. Traditionally, universities have been the prime source of new and basic information. This is still true to a very large degree despite the presence of many excellently equipped laboratories with fine staffs in industry, Government, and other research institutions. Although the research effectiveness of universities varies over an extremely wide range, it is true that the general university atmosphere gives greater opportunity and freedom for exploration. It is from this atmosphere that new ideas and approaches arise. Further, in a university, more than in any other type of institution, we find that the prime motivation tends to be research per se. This often makes all the difference between success and failure in a new exploration. However, it should not be felt that universities should be rigidly confined to basic research. It is highly essential that they should also have the freedom to carry many things through the applied research phase, in order to demonstrate and to prove the validity, or lack thereof, of particular ideas.

And finally, of course, the universities are the prime source of intellectual and research manpower for carrying on the national program. Not only the students themselves, but very often members of the staff in the younger ranks, are the prime source of scientific and engineering staffs of the many other research institutions throughout the country. The adequate education of research and

development men and women in the various fields is going to be a very tight and critical problem for the country for at least a number of years to come. Universities must be adequately supported in their research, as well as in their teaching, or the Nation will be in a sadly weakened condition within another decade. I shall speak more to this point under the next item.

ITEM X. ANY SUGGESTIONS REGARDING ACTIONS CONGRESS OR THE EXECUTIVE AGENCIES CAN TAKE TO FACILITATE AND STIMULATE SCIENTIFIC RESEARCH AND DEVELOPMENT IN THE UNITED STATES AND IN THE FREE WORLD OR TO REMOVE IMPEDIMENTS THERETO

As you listen to various statements on the projected research and development pattern, you will probably find that there is an almost unanimous opinion that more Federal funds will have to be spent. Although this is unwelcome news to a body which is ultimately responsible for taxation, I see no way of escaping it. Naturally, great care should be taken to see that the funds are spent as wisely as possible but, in view of the present state of the world, it does seem that the conclusion of more support is inescapable.

I have three suggestions which represent relatively small expenditures but which I believe, if properly pursued, would pay off handsomely. Although at this time there is certainly a substantial amount of resistance to foreign aid, I would like to call attention to the importance and possibilities of the so-called mutual weapons development program which is designed to give financial and technical aid to the research and development program of the NATO countries for the development of new weapons; thus increasing the military strength of the Western World. This program has been moving along with gratifying technical results for a few years, but it has been operating on too meager a budget. I feel that it is worthy of further consideration and further support.

There is another area where relatively small expenditures could lead to substantial benefits. I am speaking of the translation of the Russian scientific and technological literature. As I understand it, the Library of Congress regularly receives 1,200 Russian scientific journals, but only 30 of them are regularly translated. The many, many thousands of untranslated articles represent a serious blind spot in our technological knowledge. Not only are we unaware of many of the things that the Russians are doing. Also, some of the basic knowledge might be found in these articles which would make it unnecessary for us to pursue some of our own research. I suggest that there be appropriations for handling these translations and keeping them all well up-to-date. It seems logical to me that the Armed Services Technical Information Agency could be the one to assume this responsibility, with appropriate financial support.

Finally, I would like to speak of the support of university activities. Are you well known, nearly all universities are in serious financial straits. It is also generally true that the more research a university does, the more serious its fiscal difficulties. In large measure this is due to the fact that, in practically no instances, do any of the Government agencies pay the full, that is, direct plus indirect costs, of research which is undertaken on Government grants or contracts. The losses on many projects, especially those supported by certain agencies of the Government, are often very severe. The more pros-

perous a university is in such research, the greater the loss. The inevitable result is that faculty salaries for both teaching and research have to be left at an unrealistically low level. To put it mildly, this has certain deleterious effects. Because of low salaries, faculty morale tends to shrink to a low level. This is almost universal at the present time. Second, the better research men keep receiving tempting offers of higher salaries from Government agencies and from industry. Many of them accept such offers. This leads to a continual leeching away of the best talent and the weakening of the research accomplishments in the universities, which are the most important source of basic research as well as of scientifically trained manpower. This definitely is not in the public interest and the situation should be remedied.

I can illustrate the situation best by citing the current experience of the institution which I know best and which I now head—the University of Buffalo. For the fiscal year 1957, the indirect costs (overhead) associated with research as established by our firm of public accountants, in accordance with accepted accounting practice, was 82.17 percent of direct salaries. During this fiscal year, 1957, this university carried on $1,945,508 worth of research on contracts and grants. The direct salaries involved were $1,046,505. Accordingly with the above-established percentage, we should have received $859,913 for indirect costs. Actually, the total amount we did receive to cover these costs was only $255,838. Thus the loss on research operations at my institution for this one year was $604,075. Had this latter sum been made available, it would have been used largely for establishing more equitable salaries and would thus have greatly improved our research performance and potential. The total operating cost of my institution for both instructional and research work during this same fiscal year was $6,114,055. Thus the amount of loss on the research contracts was 9.9 percent of the total budget. Such a percentage loss can well make the difference between making or breaking an institution, or between low and high performance. In this instance, 34.8 percent of the research losses were from Federal Government contracts or grants. It is almost certain, because of the various national trends, that an increasing percentage of the research support in my own institution will, in the future, be coming from the Federal Government. So, the situation will become worse instead of better, unless remedial action is taken. This is typical of many other universities.

Mr. McCormack. Remedial action would be administrative, wouldn't it?

Dr. Furnas. I suggest that there be legislation permitting, or requiring, all Government agencies to allow full costs, both direct and indirect, on those segments of research supported by Government contracts or grants. The additional dollars required would be relatively small but the returns in basic research results would be outstanding.

Mr. McCormack. I ask this question there: Isn't that authority that now exists in law?

Dr. Furnas. As I understand, it is not.

Mr. McCormack. You mean anyone in the Defense Department making the contract with your university would be the only one?

Dr. Furnas. I am speaking particularly of the National Science Foundation and the National Institutes of Health. In the Defense

Department contracts, most of these are on the so-called blue-book formula, which was set up by the Office of Naval Research as a criteria for the overhead, which is certainly far better than the other Government agencies do, but I still think it isn't good enough. The overhead computed by cost inspectors of our institution this past year on the blue-book formula was 63 percent. As I say, it should be 82. But particularly the National Institutes of Health and the National Science Foundation give completely inadequate overhead percentage, if any at all.

Mr. McCormack. I mean they have the authority to do it, but they might be limited by appropriations. I was wondering about the organic law and the authority to do it.

Dr. Furnas. I may be wrong on this, but it has been my understanding that further legislation would be required. Now I may well be wrong on that. These arguments may be used for excuses, rather than real reasons.

Mr. McCormack. We will look into it anyway. The thought in my mind is, if in your close position with the Defense Department and the contributions you have made, if you couldn't do better for your university than you did, what about the other universities whose presidents are not in the position you are in?

Dr. Furnas. I can say, sir, that the bulk of our activities are in medical research and there is a large amount from the National Institutes of Health.

Mr. McCormack. We appropriated $213 million for this fiscal year, as I remember, didn't we, Charles?

Mr. Brown. Around that amount.

Mr. McCormack. It was for medical research—in that field. I remember not so many years ago we used to give a million or two million dollars.

Dr. Furnas. This may be an administrative aspect rather than legislative, but I have been led to believe that legislation would be helpful on this. I do know that consideration has been given to these matters of overhead for universities, and similar research institutions, by various agencies of the Government and by Congress. I urge that continuing and serious attention be given to these matters and I trust that favorable action will be forthcoming.

In summary, since the beginning of World War II, there has been a remarkable upsurge in both the support and the productivity of the national-research program.

Were it not for the very rapidly rising competitive position of Russia in the economic, industrial, propaganda, and military fields, we could feel satisfied with the present situation. In terms of fulfilling physical human needs, America, by any yardstick, is far ahead of any other nation. This accomplishment is based to a large degree on a highly effective pattern of industrial research. Despite some noisy cries to the contrary, I feel that this pattern of industrial productivity and civilian well-being must be maintained. In the long run, America must not only demonstrate the virtues of modern industry, but must help other nations to go and do likewise. Certainly the permanent peace which we all seek must first of all be based upon a reasonable standard of living for all people. In the long run, this demonstration and helping of others to realize what science and technology can do for human well-being is the greatest strength of western civilization.

However, until permanent peace is a much firmer prospect than at present, we must forge ahead on all lines of research and development so we can maintain our slender lead in the basic contributions to human knowledge and in military developments. This will call for a substantial strengthening of our entire educational structure and for close cooperation and collaboration with our western allies, who have a much greater scientific potential than we are now utilizing. This will require a great deal of honest effort and, for the time being, substantial increases in financial support. But it is the cost of survival. We may thus gain time to help establish a sound and humane basis for a universal peace which eventually must come, whether in this generation or some later one.

Thank you very much for listening to me.

Mr. McCormack. Mr. Fascell?

Mr. Fascell. No questions, Mr. Chairman.

Mr. McCormack. Mr. Brown?

Mr. Brown. First of all I want to apologize for coming in just a bit late, but I have read this statement and I think I have caught up with you. I wish to compliment Dr. Furnas for his report and statement. It is certainly encouraging, especially the latter part.

However, in private life, I am a newspaperman and newspapermen are often a bit cynical. While I realize fully the great contribution you have made, both in the field of education and to your Government in the positions you held here in Washington, I can't help—and I have to say this, Doctor, if you will forgive me—I can't help but relate the statements you make here about the need for greater grants to universities for research, and more money, with the fact that at the heading of your statement you are designated as chancellor of the University of Buffalo. Does that leave you open to a charge of, by someone uninformed, someone other than members of this committee who had no opportunity to talk with you, and to listen to you, to the charge that perhaps you are a party of interest and that you have made a good plea for the university research program?

Dr. Furnas. Well, I hope I made a good plea for the university research program, and I think if someone accused me of having a slight vested interest in the subject I would have to admit they were correct. But I tried to be objective.

Mr. Brown. In other words, what we get here so often in Congress, and properly so—don't misunderstand me; there is nothing disgraceful about it—but we get the views of persons who are interested in one particular thing, while we have to pass upon it and other problems on a general basis, as to its affect on the whole country, and on all of our economy, for instance, you can't convince me but what certain things which benefit the newspaper business isn't of great benefit to everybody.

Perhaps I am a bit prejudiced in my viewpoint, but I am just wondering if that charge might not be made here, that because of your connection with the academic field that you are perhaps a bit prejudiced.

Now let me ask you 1 or 2 questions, if I may, and please remember I do not mean there is a wrong kind of a prejudice. I respect a man who stands up for what he believes in. But how many of these universities that are receiving—and I admit they are doing great work in research—how many of them have had these research projects forced

on them and how many have sought these funds and programs from the Government? In other words, if it entails a great loss, I am wondering why so many of the universities, if they operate at such a great loss, seemingly want these research assignments? I have had some contact me saying, "Can't you get them to give us certain research jobs to do."

Dr. FURNAS. In the first place, if you are going to have a university of any status, you must have a substantial research program.

Mr. BROWN. I agree we ought to use the research facilities where we can find them.

Dr. FURNAS. Let me say it is an essential part of their activities. You must have instruction and you must have research, so that they do seek it and they seek it where they can get it.

Mr. BROWN. Even if you lose money; even if you lose $800,000 a year, you still seek them?

Dr. FURNAS. Yes, sir.

Mr. BROWN. My university keeps sending me pleas for alumni contributions saying that they are having a hard time to balance the budget, and it looks peculiar to me that they would go out and search for assignments that meant greater losses to the university.

Dr. FURNAS. Well, but they do.

Mr. BROWN. It is sort of a paradox, isn't it?

Dr. FURNAS. It is a paradox.

Might I just cite you another instance of a rather well-known university? This is an excerpt from the Atlantic Monthly in June 1950, from an article "Can We Pay For Our Medical Schools" by Dr. Darling, who is director of medical affairs at Yale University. I quote him under the subheading "No Money for Overhead":

> But surely with all of these headaches, these grants-in-aid must prove a financial bonanza to the medical school? When the Government builds a ship or a school, it expects to pay the contractor his operating overhead and a profit besides. A nonprofit institution cannot, of course, make a profit. But certainly the schools should be given enough to cover the operating cost? Not at all. The outmoded custom of 20 years ago still dominates.
>
> For example, Yale has out-of-pocket operating expenses and overhead of 25 percent, with only emergency outlays for building rehabilitation. This will not seem unreasonable to any businessman or industrialist. If the grantors, in view of the plight of the schools and the value of their contributions, were willing to pay the indirect, as well as the direct costs of the work carried on under their grants, Yale would receive $200,000 instead of the $40,000 it obtained for this purpose a year ago. Sometimes it almost seems that every precaution is taken to ensure that no dollar by mistake should go toward the major program of the schools, which, curiously enough, is training of the very men upon whom all research depends.

Now the situation is much worse than it was in 1950.

Mr. BROWN. Now just to conclude on that line of questioning, I feel very strongly that if the Federal Government uses the facilities of a college or university for research that they should pay the costs, meet the costs thereof, and on a reasonable basis and a fair basis. I don't think that the Government has the right to call upon any institution of that kind, like a college or university, or upon any private industry or business, to furnish something at a loss for the benefit of the Government itself. So in that instance I am certainly in agreement with what you have said.

Now let me explore your mind, if I may, for one more minute. How far should the Government spread its research programs?

Where is the line of demarcation between what the Government should do and should finance in the field of research and what it should not do?

In other words, I have a chair factory in my district. Should the Government have a research program in my district on how to build chairs, make them more comfortable? They have engineers out there that study it all the time, how to make them more comfortable and durable in every way. Should the Government have a research program on that or should private industry do it? Where should this stop and start?

Dr. FURNAS. Taking your first instance, I feel that should be the industrialist's responsibility.

Mr. BROWN. So do I.

Dr. FURNAS. You will never get universal agreement as to how far the Federal Government should go. I think the criterion is if there is something really serious that needs to be done of a national interest—military, health, or anything else—as long as there is not adequate support coming from elsewhere, then I feel it is the obligation of the Government to support that. What criterion you should supply, how severe is the national interest, that is where you have the arguments. I think that is the criterion, however.

I would like to see, personally, more industrial money going in to support research, whether the work was done in their own organization or in others, just as I would like to see more industrial money going to the support of education.

Mr. BROWN. Isn't it a fact industry supports a great many of these college and university research programs?

Dr. FURNAS. They help out quite a bit, and I think they should do more.

Mr. BROWN. They contribute rather heavily, don't they?

Dr. FURNAS. In some cases, but I think they should do more.

Mr. BROWN. Are you speaking as a university professor, or in an abstract sense?

Dr. FURNAS. I think I am speaking in an abstract sense. I hope I am. I think in my little preamble there I tried to indicate that, it is impossible for anyone to be completely objective in such a controversial issue; however, I was going to try to be as objective as I could be.

Mr. BROWN. What is your idea of the line of demarcation as to what the Government should do or support in the way of research?

Let me preface that by saying Mr. McCormack and I have been in the Congress for a long time. I won't say that about the lady Member because she is so young. But I recall that we have taken many steps in medical research, of which originally there was very little. I believe you will agree, Mr. McCormack, that it was the general thought of those of us who supported the bills in the field of medical research that the Federal Government should do that which the States and local communities could not do for themselves, and in training of individuals to carry forth new methods for the practice of medicine, surgery, and so forth. But someplace—it was difficult for us, and it is still difficult to draw the line—but someplace there has to be a line drawn, doesn't there, between what the Government should support and do and what private industry, or private educational institutions, should attempt to support and do?

Dr. FURNAS. I think there is such a line, but I am afraid it is as indefinite as the banks of the Gulf Stream; there isn't any definite boundary.

Mr. BROWN. I can go out and find the Gulf Stream, but I am not sure if I can find the line of demarcation.

Dr. FURNAS. I think the answer you always arrive at, and it is always on a case-by-case basis, is the summation of the social pressures. I wouldn't say "political pressures"; you might misinterpret me on that, but I would say the social pressures.

Mr. BROWN. Should it be the social pressures or the absolute needs for defense and security?

Dr. FURNAS. These are the social pressures I am speaking of.

Mr. BROWN. Medicine is mostly a social pressure, but it ties in.

Dr. FURNAS. I am speaking of social pressures very broadly because we must have an adequate defense because America wants to be America and the people want it.

Mr. BROWN. We wouldn't have much social activity if we are not secure.

Dr. FURNAS. Right.

Mr. BROWN. I would like to ask you one other question. From your broad experience in government, as well as in education, do you feel that rivalry between the various branches of the armed services has materially interfered with our research program in the field of military weapons, missiles and satellites, and so forth?

Dr. FURNAS. Yes, sir, I do. I am not denying the principle, sir, of the importance of competition, but I think that this, in many cases, has become more or less unbridled competition; perhaps analogous to the railways before there was any consolidation or regulation. This type of competition, if I read the history of transportation correctly, was deleterious in the early days of railways. So I think this is rather analogous to the Department of Defense. There has been too much competition, with the high degree of autonomy of the individual services.

I want to say also, I certainly have the highest respect for all of the people I had contact with in the services, both in uniform and out, for their dedication and particularly their hard work, and I must say if I had been associated with one service, I would have felt the same degree of loyalty and I would have pursued the building up of my particular service, just like everyone else did.

Mr. BROWN. Doctor, did you find, while you were in public office, many instances where a research problem was solved by one branch of the Armed Forces and the results were not passed on to the other branches, with the result, the other branches of the armed services were devoting time and effort and money to trying to solve the very same problem?

Dr. FURNAS. There is some of that. Because of the magnitude of the work, there is a great delay, but on the research end, that is, the scientific part, there is not very much, if any, jealousy. There may be a little bit of thumping of chests, but it is not serious. But where the seriousness comes in is in terms of unnecessary use of manpower and money in the development projects. There you often have a parallel development between two services and you carry them on through the very expensive stages and you come out with similar weapons, both of which cost several hundred million dollars. You even find that within the different branches of the service you have

this sort of unnecessary carrying through of development, and that is where the thing gets to cost a lot of money and take a lot of time and talent.

Mr. McCormack. And delay and frustration.

Dr. Furnas. Yes, sir.

Mr. Brown. Do you have any solution to the problem to suggest?

Dr. Furnas. I did in the early part of the text, before you came in, Mr. Brown. I stated that I felt that there should be more control at the Office of the Secretary of Defense.

Mr. Brown. I read that—at the high level?

Dr. Furnas. Yes. Not approve any projects for budget consideration which are going to take any production funds before it has been thoroughly cleared by the Secretary of Defense.

Mr. Brown. Of course that is what we thought we were going to get, in a general way, when we passed the Unification Act out of this committee, but I am fearful we have not got it.

One other question. You have been very patient, Mr. Chairman and Dr. Furnas. A part of the research work on these missiles and satellites, new weapons, and so forth, as I understand it, and a rather substantial part, has been done by universities and by private industries; is that correct?

Dr. Furnas. Yes, sir.

Mr. Brown. And a part by the various armed services and their personnel?

Dr. Furnas. Yes, sir.

Mr. Brown. Now in your opinion, Doctor, do you feel that we would get along more rapidly toward solving our missile problems if more of this research was done in the universities, and in private industry, and less in the Armed Forces, or vice versa?

Dr. Furnas. Well, Mr. Brown, certainly a pat answer is dangerous, but I do have the feeling, as I expressed in here, that we are probably leaning a little too heavily on the Government establishment and I would like to see more go to the private institutions and to the universities, perhaps a little more to industry.

Now, in saying that, you will say that I am prejudiced, and perhaps I will have to agree with you, but I don't intend to be.

In answer to your question, I do feel that we are probably relying too much on the governmental establishments in view of the American social structure and economic structure.

Mr. Brown. Well, you are very frank and a very able man, Dr. Furnas, and you have a brilliant mind. I want to congratulate you and I want to thank you for your patience.

Mr. McCormack. Mrs. Harden?

Mrs. Harden. No questions.

Mr. McCormack. Mr. Michel?

Mr. Michel. You stated in your testimony that in industrial practice not more than 1 initial research idea out of 10 survives into the development stage, and that this is considered to be reasonable and satisfactory.

Dr. Furnas. Yes, sir.

Mr. Michel. And you state, further, that in the military area that 1 research idea out of 2 moves into development. Do you mean to say by that, or to imply that people in industry have much more factual information for determining whether or not it is economically feasible

to go ahead than those minds in the military, or that the military has so much more money proportionately to play with that they just take the benefit of it and say, "Let's go ahead"?

Dr. FURNAS. It isn't a matter of ability; it is a matter of motivation. Industry has a very strong and direct motivation to allow only those things to survive that are probably going to be successful. That, of course, means making profit. So this is a very effective motivating factor in your filtering of what you are going to do. If you make very many mistakes, you don't exist very long.

This motivation and this criteria do not apply to the governmental activities. The economic criteria is one of the most severe filters you can have. However, in the Government, as you say, there is more money to play with, but there is also no criterion by which you can say, "Well, we simply are not going to do this because it is not going to make any money." So it isn't a matter of ability; it is a matter that there isn't any really directive force which is going to make them look very critically at the development of something new before they start on it.

Mr. MCCORMACK. Doctor, you had an article which appeared recently in Life magazine, didn't you?

Dr. FURNAS. Yes, sir.

Mr. MCCORMACK. Without objection, I will incorporate the text of what you said in the record.

(The article reads as follows:)

WHY DID UNITED STATES LOSE THE RACE? CRITICS SPEAK UP

Dr. C. C. Furnas, a chemical engineer and expert on guided missiles, served as Assistant Secretary of Defense for Research and Development from December 1955 until February 1957. In that position and as a member of many scientific advisory committees, he has observed the progress of the United States satellite program at all levels. Now returned to his post as chancellor of the University of Buffalo, Dr. Furnas last week gave Life this exclusive and critical report on why the United States satellite has not yet been launched.

Text by Dr. C. C. Furnas

The United States should have been and could have been the first nation to launch a satellite. Some officials who now belittle Russia's sputnik are among those who, in the first place, were not convinced our own satellite program was worth pushing. Had they been so convinced, there is every reason to believe that a United States satellite could have been orbiting the earth as early as 1955. Instead, it was not until 1955 that a United States satellite program was even seriously discussed. But with vigor and determination, even at that late date we might still have got our "moon" up there first. We had the brains, we had the know-how, we had the money. Why, then, did we not get the first satellite?

All too frequently it has been the view of our Defense Establishment that research not directly related to the development of military hardware is entitled to only secondary consideration. It has been regarded as a sort of extracurricular scientific pastime to be indulged in only if money is left over from the "really important" things.

This is a tragically naive and shortsighted outlook. Every scientist knows that a single fruitful concept can render an entire weapons program obsolete and open up a host of new possibilities to explore. Out of the basic experiments on aerodynamic forces by the Wright brothers and Langley came the age of aircraft and missiles. Out of Hans Bethe's abstruse calculations on the nature of the sun's energy came the hydrogen bomb. In the case of the satellite, it was the then Defense Secretary Charles Wilson's contention (and still is, judging from his latest public pronouncements) that while a satellite is "a nice scientific trick" it has no real military value. Therefore, why spend military money on it?

It was not that our Defense Department lacked the money. It lacked only the interest. The Pentagon seemed unable to see the obvious military advantages of a satellite, even though some scientists and officers in the military forces were most vocal in pointing them out more than a decade ago.

In 1954 after plans got underway for the International Geophysical Year, an urgent interest in an American satellite was expressed by the National Academy of Sciences, sponsoring agency for the United States IGY program. But the Academy had no money. It turned for help to the National Science Foundation, the agency created by Congress to encourage basic research. But the Foundation's funds were puny compared to the magnitude of the task, and Congress showed no disposition to appropriate more. Despite this lack of support, by the spring of 1955 enough high-level interest had been generated to spur Donald Quarles, then Assistant Secretary of Defense for Research and Development, to appoint a 9-man, all-civilian scientific advisory committee. I was a member of this committee, which met several times during the spring and summer of 1955.

First we were asked to decide on the feasibility of launching a satellite in time for IGY (mid-1957 to the end of 1958). We were well aware of many thorny problems which had to be solved. Nevertheless we agreed that there was a reasonable hope of doing this if the personnel, facilities, and funds were granted on a high-priority basis. Next Mr. Quarles told us there was $20 million available in the Defense Department's emergency research-and-development fund. Would that be sufficient to do the job? Our answer was a unanimous, resounding "No." We all agreed that several times that amount would be required for the project.

Finally we were asked to select one of three service satellite proposals: (1) The Army believed that its giant Redstone missile could be perfected as a launching vehicle within a year and that its scientists could develop the satellite and instruments in time for IGY. (2) The Navy was much farther ahead in instrumentation, but its Viking missile would need a redesigned motor with added thrust in order to lift the satellite high enough and fast enough. (3) The Air Force offered the mighty Atlas missile, but it was cautious about promising any definite delivery date.

The committee toyed with plans for combining the best features of all three proposals—for example, trying to use the Army's farthest advanced missile to launch the Navy's farthest advanced satellite instruments. But putting together parts of the separate systems involved certain difficulties, technical and administrative, I recalled, for example, sitting in on earlier meetings as Chairman of the Guided Missiles Committee of the Research and Development Board. We tried to persuade the Navy and Air Force to combine their skills in producing a single 500-mile range, subsonic, surface-to-surface missile. Each service thought a single missile was a fine idea. But if there was to be but one missile the Navy thought it should be the Navy's and the Air Force thought it should be the Air Force's. As a consequence, we have two such missiles—the Air Force's Matador and the Navy's Regulus.

All of us had had similar experiences with the military services. We were familiar with the rivalries and jealousies that would cause delay and frustration. We knew of the unwillingness of one branch of service to contribute personnel, money—or even information, at times—to a project for which some other branch would get the most credit. We all felt that a joint-effort satellite would take a long time to get off the ground, much less reach outer space. We finally decided that breaking the space barrier would be an easier task than breaking the inter-service barrier. If the job was to get done in a hurry, it had to go to a single branch of service.

Once this was decided, the assignment was a tossup between the Army and the Navy plans. Four Committee members felt it would be wisest to take advantage of the Navy's lead in satellite instrumentation and trust that the needed power could be built into the Navy missile in time for IGY. But one other member and myself cast dissenting votes. We felt that the Army's advanced rocketry would make possible an earlier satellite launching. The remaining three members said that, since they were not missile experts, they would go along with the majority. Quarles was handed this split recommendation. After a careful study, he assigned the job to the Navy, and it became known as Project Vanguard. Quarles' decision was purely technical. No politics were involved.

From the beginning we were stymied by the chronic monetary constipation of the Armed Forces wherever expenditures which they consider nonmilitary are concerned. Money was squeezed from odd corners of the various military budgets,

and we got all the help which the National Science Foundation could give us. But the funds were dribbled out in such a manner that work was often slowed up for weeks and months at a time.

Then a new blow fell. In the original budget discussions we had understood that whenever we used the facilities of the Army, Navy or Air Force, they would absorb the housekeeping expenses. But meanwhile there had been a drastic revision of the military accounting system. As a result, when we used, say, Patrick Air Force Base in Florida for a missile test, we had to pay rent for use of the missile range and also pay the cost of all the personnel and equipment we needed. These enormous, unexpected expenses raised havoc with our already tight budget.

To make matters worse, the program lost the leadership of Quarles, who moved up in August 1955 to become Secretary of the Air Force. For several months there was only an Acting Assistant Secretary for Research and Development in Quarles' place. Then in December I took over the job. Sitting in his seat, I got an even better insight into the difficulties of reconciling the numerous inter-service rivalries. It was during this period, for example, that the well-publicized row occurred over whether the Nike or Talos should be our standard antiaircraft missile. The Army pushed the Nike, but the Air Force insisted on using the Talos to defend its SAC bases. The matter was finally solved, not by dropping one of the missiles but by assigning the Army responsibility for both. (There was still a third one—a special Navy Talos for shipboard launching.) As Quarles' successor, I also had jurisdiction over the satellite program, but it never did receive the high-priority status it would have needed to get it into its orbit before the Russian sputnik.

Let us not pretend that sputnik is anything but a defeat for the United States. During World War II, when officials were trying to make light of a discouraging setback in the Burma campaign, Gen. Joe Stillwell said impatiently, "I claim we got a hell of a beating." We might as well make the same admission regarding the Russian satellite. We did, however, go back and win in Burma. In order to go back and win the race for scientific supremacy, there are some things we must do.

We must revise our naive attitude toward basic research. The armed forces must understand that money spent on background research is not money thrown away. And Congress, now that it has created the National Science Foundation, should have the courage to vote it the funds it needs to carry out its many important programs.

We must give much more aid and encouragement to our educational institutions in turning out more engineers and scientists, especially at the graduate level.

We must change our public attitude toward science and scientists. At a time when Russia was building a scientific elite, we were treating our patriotic scientists with hostility and suspicion. No one can accurately estimate the amount of damage that was done.

Finally, we must somehow reorganize the obsolete administrative structure of the armed services. There is no reason why a civilized nation should not be able to use all the money and all the talent and all the facilities of all its branches of military service on those programs which it decides are consistent with the best national interests. In the case of the space satellite we had the money and talent and facilities to do the job—but only in pieces, with the pieces trapped within the high fences surrounding the individual services. Unless we can devise without delay some means of putting the pieces together and keeping them together on a permanently functioning basis, I am afraid that we will soon find ourselves gaping at still further Russian triumphs.

Mr. McCormack. In that article you prepared at that time, you were very frank and direct, and probably more so than the testimony today, covering these aspects; is that correct?

Dr. Furnas. Well, it might be I had a high head of steam at that time.

Mr. McCormack. In the article you mention the question of the nine-man committee appointed by Mr. Quarles. He is Under Secretary, is he not? I like to get the titles correct.

Dr. Furnas. Mr. Quarles was Assistant Secretary for Research and Development at that time.

Mr. McCormack. This is the nine-man committee appointed by Mr. Quarles.

Dr. Furnas. This committee was appointed by Mr. Quarles to advise him on the satellite program and that was part——

Mr. McCormack. What advice did you give him at that time?

Dr. Furnas. We had a split paper. There were two of us who felt, and I think we felt quite strongly at that time, that the better program to pursue was the one which the Army proposed. There were, if I remember correctly, five of the others who felt quite strongly that the Navy program—now known as Vanguard—was better. There were two who said, "Well, we are really not qualified on these rockets." So we turned in a paper in which two of us advised Mr. Quarles we felt that the Army program should be pursued and the majority felt that the Navy program should be pursued. There was also one other man, not really a member of the Committee, but a consultant, and he concurred with the Army program. So you can say 3 to 7.

Mr. McCormack. Those seven who passed on it and consulted, they all agreed that the satellite, whether the Army or Navy, should be pursued?

Dr. Furnas. We all agreed it should be pursued, no question on that. The disagreement was as to which service.

Mr. McCormack. Was it pursued?

Dr. Furnas. The satellite program?

Mr. McCormack. Yes.

Dr. Furnas. Yes; it was the Vanguard program.

Mr. McCormack. Now in your article you said it was not that our Defense Department lacked the money; it lacked only the interest.

Dr. Furnas. Yes, sir.

Mr. McCormack. You state that the Pentagon seemed unable to see the obvious military advantages of the satellite, even though some scientists and officers of the military forces have been most vocal in pointing them out more than a decade ago.

Dr. Furnas. Yes, sir.

Mr. McCormack. And that it was the view of the Advisory Council, the seven——

Dr. Furnas. I should not say I am speaking for the Advisory Council there; this is my own thought there. I was trying to give the facts back of it and to analyze what I felt about the conflicting forces in the Department of Defense.

Mr. McCormack. Who are the other members of that advisory committee; do you remember?

Dr. Furnas. Yes; I remember. I am not sure that I am entirely free to give that because——

Mr. McCormack. Let me ask you—there was yourself, and was it Dr. Homer J. Stewart?

Dr. Furnas. Yes, sir.

Mr. McCormack. Dr. R. R. McMath?

Dr. Furnas. Yes, sir.

Mr. McCormack. Dr. C. C. Lauritsen?

Dr. Furnas. Yes.

Mr. McCormack. Dr. John B. Rosser?

Dr. Furnas. Yes, sir.

Mr. McCormack. Dr. Richard W. Porter?

Dr. Furnas. Yes, sir.

Mr. McCormack. Mr. G. H. Clement?
Dr. Furnas. Yes, sir.
Mr. McCormack. Dr. Joseph Kaplan?
Dr. Furnas. Yes, sir.
Mr. McCormack. And one other I have not named?
Dr. Furnas. Well, Mr. Paul Smith.
Mr. McCormack. Dr. Carl Smith, or Mr.——
Dr. Furnas. No, sir; he was Mr.
Mr. McCormack. Well you said there was a nine-man advisory council.
Dr. Furnas. How many names was that you read?
Mr. McCormack. Dr. Stewart, Dr. Furnas, Dr. McMath, Dr. Lauritsen, Dr. Rosser, Dr. Porter, Dr. Clement, Dr. Kaplan.
Dr. Furnas. That is only eight.
Mr. McCormack. Will you furnish the other name for the record?
Dr. Furnas. Yes; his name is Dr. Francis Clauser.
Mr. Michel. Mr. Chairman, may I ask a question here?
Mr. McCormack. Certainly.
Mr. Michel. Then apparently this Advisory Council ruled in favor of the Navy Vanguard. As a result of the Navy Vanguard making two failures, apparently now the Jupiter-C is being given the opportunity. As we read in the press, apparently the minority on the Advisory Committee, if it should succeed, made the proper decision, rather than the majority?
Dr. Furnas. This could be, but I am willing to say these were honest judgments, and they were matters of technical differences of opinion. So I do not think that there should be any air of condemnation on this.
But of course I would say that I would feel that it would bolster my feeling of the correctness of our minority opinion if the Army should succeed on this.
Mr. Fascell. Of course, that is the point there, Mr. Chairman.
The point there, Dr. Furnas, was, the technical differences are O. K., they are subject to evaluation and whatnot. However, the main issue was, the main program itself was deemphasized at the top level.
Dr. Furnas. That is correct.
Mr. Fascell. You also had one other problem, as I recall it, and that was the deemphasis in the Department of Defense on basic research——
Dr. Furnas. That is correct.
Mr. Fascell. As an unnecessary luxury.
Dr. Furnas. Yes, sir.
Mr. McCormack. Is that the reason for getting it out of the Defense Department—that I asked you questions about before, I mean, on the top level? Human nature is the same, you know.
Mr. Fascell. You could answer it another way, Mr. Chairman.
Mr. McCormack. I was not asking you. [Laughter.]
Dr. Furnas. Well, sir, I would rather see the Defense Department strengthened.
Mr. McCormack. I agree with you on that.
Now I can go along with you on the Defense Department. They should be strengthened. There should be reorganization, but what about something on a higher level, on the civilian level, in a position as immediate to the President as is possible?

Dr. FURNAS. Well, sir, I feel that the National Science Foundation has this role for the——

Mr. MCCORMACK. I am a great supported of the National Science Foundation, and we had trouble in getting it through, and I spoke for the bill.

But that, important as it is, has a broader scope. It embraces it, but it is broader. We are now confronted with a pretty immediate situation. You realize, of course, that the next year or year and a half will be pretty trying periods, and we do not want to deceive ourselves. We have to do some quick work in certain fields, because if the Soviet Union ever gets ahead of us, where they can hit our targets, and should perfect defense against our intercontinental bombers where we could not hit their targets—anyone who thinks they are going to let us catch up with them is, in my opinion, living in a dream world.

They might first submit terms which, if we accept them, would be capitulation. And by the way, if you will notice the papers, Mr. Khrushchev is getting closer and closer to the point about the matter. He is taking those stages, and the last stage was a pretty marked stage. He is a pretty arrogant individual, and you will notice in the last statement he made he said they had the means, the instruments, the facilities, the weapons—he did not use that exact language, but that is what he meant—to hit any place in the world.

And so it is a question, from the American angle, it is imperative—is it imperative, Doctor, in your opinion, that within the next year or year and a half, that we act quickly in catching up where we may be deficient?

Dr. FURNAS. In the military?

Mr. MCCORMACK. In the military.

Dr. FURNAS. Yes, sir.

Mr. MCCORMACK. Because we have to solve that to maintain ourselves. Everything else important depends on us having this country of ours——

Dr. FURNAS. I am not sure, sir, about your time scale, but certainly within 5 years. This is correct, sir.

Mr. MCCORMACK. Well, we read about the antimissile missile. All I know is what I read in the newspapers, and therefore, I am not disclosing any classified information.

And I can ask you questions on what I read in the newspapers, and you can answer them if you want to, and if you do not, you feel you should not, I would not press them. I realize the delicacy of your position.

So I assume from that that our Government is, through its basic and applied scientists and others, giving searching and primary consideration to that problem?

Dr. FURNAS. Yes, sir.

Mr. MCCORMACK. We want to try and get a device, a means, of hitting those intercontinental ballistic missiles before they land here, if we can do it?

Dr. FURNAS. Yes, sir.

Mr. MCCORMACK. If we can do it; if it can be done. Well, it is fair to assume that the Soviets are thinking along the same lines, and acting along the same lines, isn't it?

Dr. FURNAS. I think that is a fair assumption.

Mr. McCormack. In that field it is sort of a race for time. Our main deterrent, our main defense——

Dr. Furnas. Yes, sir.

Mr. McCormack. Notice I say primarily fast. I am not disregarding any other part of our services, they are all important. But if the day ever arrives where they perfect it before we do, and they in turn perfect the intercontinental ballistic missile before we do, we are then faced with a very serious situation of survival.

Dr. Furnas. Yes, sir; if they have it perfected.

Mr. McCormack. As long as they adhere to world revolution, world domination, and imperialism, which they are.

Dr. Furnas. Yes, sir.

Mr. McCormack. There is no evidence of any change. We have to be realistic, we have to face it, we cannot deceive ourselves at all. Am I right, Dr. Furnas?

Dr. Furnas. You are correct; yes, sir.

Mr. McCormack. So it is imperative, whatever that period of time is, and I do not know what it is—I know different men vary as to that, competent men, honest men, dedicated men, and you are a dedicated man. But whatever that period of time is, we cannot afford to let them get a decided advantage over us, not only in intercontinental ballistic missiles and stopping all bombers from getting there should they engage in a surprise attack, but in the field of biological warfare, chemical warfare, psychlogical and whatever others there are. Is that right, Doctor?

Dr. Furnas. Yes, sir.

Mr. McCormack. It is a question of operating on the law of self-preservation. Because they cannot deny the law of self-preservation applies to the Soviet Union and our people any more than it applies to others; is that correct?

Dr. Furnas. That is correct, sir.

Mr. McCormack. In other words, in your opinion, as I evaluate your testimony, we have to make a lot of reassessments, and we are not confined to the field of research and development, or broader reorganization, or whatever it might be, of the Defense Department. And I might say my mind is open. The thoughts I had 10 years ago, I am keeping them open because we are in a different world today, and we have to realize that. But we have to have the guidance, and it must come from proper management. Is that correct?

Dr. Furnas. Yes, sir.

Mr. McCormack. It must be those minds on the top level, with the power to make decisions and authority to carry them out, to see that they are done; is that correct?

Dr. Furnas. Yes, sir.

Mr. McCormack. Am I incorrect? I won't say, "Am I right."

Dr. Furnas. I feel you are correct.

Mr. McCormack. But there is a time period there. No matter what it is, we have to at least catch up, we have to try to go ahead, but at least catch up. Because we cannot afford to let them have an advantage, where they can hit us and we cannot hit them. That is the problem that faces America?

Dr. Furnas. That is correct.

Mr. McCormack. Not Democrats or Republicans, or Independents, but all of us. And all of these Members here are dedicated.

Mr. Brown. I would like to comment on what the gentlemen said, because there are some very helpful thoughts in your statement and in your question. Now the difficulty I have had as a Member of Congress, and I think perhaps other Members of Congress have had the same difficulty—is to ascertain what the truth really is, to know exactly what is going on. We will read these things in the newspapers, we will hear testimony. We have the problem, for instance, of what we are going to do about the basic reorganization of our Defense Establishment, and two men of the stature of General Spaatz and Admiral Nimitz come up and testify to contradictory things. Their beliefs are entirely opposite as to the best way to bring about the desired results. Scientists come up here, and give us entirely different pictures, one has one opinion and one has another. And then our lay minds are called upon to decide who is right and who is wrong, and what is the best system and the best method to follow to obtain the results which Mr. McCormack said we all want, which is true. Other public officials do the same thing.

Now, I think our most difficult problem right now is to find out just what exactly the truth is, and then our next big problem, after we have learned the truth and know what the true question before us is, is to have the wisdom to come up with the proper solution.

You have noticed that, haven't you, Dr. Furnas, the different testimony and the different statements made; that one day some man testifies and tells us how dangerous the situation is, that the Russians already have this and we already have that, and later we will wind up with someone else saying just the opposite.

We are talking about these new missiles to intercept ballistic missiles. How far are we along in our progress in producing them, or in even getting them ready for production? Is this just a pipe dream, or is it something upon which we can expect accomplishment within a short time?

Dr. Furnas. Well, I might say, sir, that as far as our preparing them for production in ballistic missiles we are getting quite far along, and I think the program is progressing very rapidly and very soundly. It should have been started 5 years earlier.

Mr. Brown. I agree with you.

Dr. Furnas. We can always cry in terms of hindsight.

As to what is the truth, I suppose one can fall back on taking the extremes, and hitting an average. You can strike the average, and I suppose you will probably come very close.

Mr. Brown. One fellow says do it one way, and another fellow says do it directly opposite, and you divide it in half, and do it half way? I do not want any of that. I do not follow your logic there.

Dr. Furnas. I meant, sir, when you said what is the truth, in terms of where do we stand now, in some programs I think if you take the extremes of the testimony you get, and strike the average, that probably is about where you usually stand.

Now in terms of organization, and how are you going to approach the solution of the problem, this of course has always been one of the human problems of how are you going to do things best, and you have to rely on the best judgment you can.

Mr. BROWN. I just mentioned that because I hope you understand that we have our problems as well as you have your research problems?

Dr. FURNAS. I realize that fully well, Mr. Brown.

Mr. BROWN. It is difficult to know. I think every Member of Congress wants to do only that which is right and in the best interest of his country. But to know, first, what action is needed; and second, what is right, is what worries a lot of us.

Dr. FURNAS. We have always been that way, sir.

Mr. BROWN. Thank you very much.

Mr. FASCELL. Dr. Furnas, do you see this area at the present time, that we have been discussing, as one of great legislative action?

Dr. FURNAS. Personally, I do not see where legislative action has a major role except——

Mr. FASCELL. In the field of appropriations?

Dr. FURNAS. Except in the field of appropriations, and a few of these things I pointed out. This is part of the running battle which we have always had between the operation and legislation.

Mr. FASCELL. In other words, what we are talking about basically then is the proper emphasis at the administrative level to do the things that are necessary to be done?

Dr. FURNAS. That is correct.

Mr. FASCELL. And if this requires legislative support of one kind or another, it ought to be forthcoming?

Dr. FURNAS. That is right.

Mr. FASCELL. But no amount of legislation or appropriation, without the proper administration, is going to be worth 10 cents?

Dr. FURNAS. Well, you can always lead the horse to water, but you cannot make him drink.

Mr. MCCORMACK. Off the record.

(Discussion off the record.)

Mr. FASCELL (presiding). Mr. Michel.

Mr. MICHEL. In one area you pointed out in your testimony revision, reorganization of the Defense Department, particularly in line with the Assistant Secretaries for each service in the field of scientific research and development?

Dr. FURNAS. Yes.

Mr. MICHEL. Now, I know of some things that have been developed by each one of the individual services. These developments are reported to their respective headman, particularly in the Army through Gavin, and there it stops, and this information could be of help to all three services. The chairman earlier wondered just what authority Dr. Killian had.

Would you envision it this way: that with 3 Under Secretaries for Research and Development, of the 3 services, reporting directly to the Secretary of Defense, and certainly he being their superior, might very well quash what they had in mind? Would not Dr. Killian, in his position, be free enough? He could go to any department of government and confer with the scientists and research people, to get their views firsthand, and then possibly get the President's ear, and say, "I think these gentlemen are being thwarted in their efforts." This question might be a very good thing. And the Commander in Chief then, in turn, conferring with the department—by way of a check and balance, so to speak, without getting away from

the direct line of authority that we know in our Defense Department—could remedy the situation, might he not?

Dr. FURNAS. I feel what you are describing there as a possibility of Dr. Killian's action is the sort of thing that he, I am quite sure, would do, or will do, or perhaps is doing—I do not know. But this is part of the advisory role, and he can be much more objective, and with the proper backing up, much more effective in that role than if he is the boss of some line organization.

This is my point.

Mr. MICHEL. Right. And I think the point is very well made, in that capacity, and I was just curious to get your further observation on it, Doctor. That is all, Mr. Chairman.

Mr. FASCELL. Thank you very much, Dr. Furnas. We appreciate your coming down before the committee and giving us the benefit of your views and advice on this problem.

Dr. FURNAS. Thank you.

Mr. FASCELL. I am sure it will contribute immeasurably to the solution of the problem.

Dr. FURNAS. I am not sure it will, but it is at least my opinion.

Mr. FASCELL. The committee would like to call Dr. Getting.

STATEMENT OF IVAN A. GETTING, VICE PRESIDENT, ENGINEERING AND RESEARCH, RAYTHEON MANUFACTURING CO.

Mr. GETTING. Mr. Chairman, I think I should perhaps introduce myself as Dr. Furnas did, although I think he had less reason to do it, because he is more notorious. [Laughter.]

I might just say for your information that I started my professional career as a theoretical astrophysicist. I spent the time before the war in the field of cosmic rays and nuclear physics at Harvard, and during the war was caught in the general forces underlying scientific applications through the military.

During the war I was head of the fire-control division of the radiation laboratory at MIT.

My group was the one responsible for the first automatic tracking gunfire control radar—the SCR–584.

The group also developed for the Navy an automatic antiaircraft gun-direction radar system, the MK–56, the most efficient of its kind at that time.

My group was also the one that was charged with the responsibility of the control of guided missiles, the buzz-bomb variety, and so forth.

After the war I became a professor at MIT until in the early phases of the Korean war I was asked by the Chief of Staff of the United States Air Force to assume a rather unique position, known as the only civilian holding the line job Director of Development Planning for the Air Force.

This was when the project Charles, and a few other more or less controversial programs, got underway.

After that, I went to Raytheon Manufacturing Co., where I am and have been since that time, vice president engineering and research.

I have my prejudices, as do all others, and I am appearing here today primarily as a spokesman for industry, although I believe that my rather unusual experience in the area of your interest does give

me some reason to have opinions on almost all the areas that have been discussed.

I will revert now to my prepared remarks.

I was asked by Mr. Poland, your counsel, to appear before you and present you with my views on research and development in industry, particularly in its relationship to the national military effort. I regard this as a privilege, as well as a real opportunity, to bring before you a situation in which Congress can be of major assistance.

It is well known that scientific research and technological progress result from work done at universities, Government laboratories, nonprofit institutions, and private companies.

A great deal of thought has been given to the problems facing universities in their research programs. Strong supporting letters have come from such groups as the President's Scientific Advisory Board, Naval Research Advisory Committee, and others, in favor of increased emphasis on basic research in universities.

As commendable as these expressions of views are, it still remains a fact that the bulk of scientific research and technological development of interest to the Department of Defense resides in industry.

If I can depart now, and just point out that a number of the American Nobel prize winners mentioned by Dr. Furnas were in industry: Davisson, Germer, Langmuir, Schockley, Bardeen, Brattain, and a few others also came from industry.

So not all basic research is in universities.

In fact, according to a recent survey of the National Science Foundation, the number of professional people engaged in universities and nonprofit research organizations combined is 32,000; Government laboratories 37,000; and industry 157,000.

It is not intended here to detract from the importance of the roles played by universities, Government laboratories, and nonprofit institutions. Rather, I would wish to support them in every way possible as essential and contributory members of the overall team. However, I am here today as a spokesman for industry, and as such I wish to present for your consideration some of the problems facing industry in research and development, and some possible solutions that might overcome present shortcomings.

In order to put the subject in perspective, it is necessary for me to draw a picture of research and development in industry as it supports our national effort.

And in this instance, I have in mind, particularly, national defense.

I will necessarily draw upon my experience in this regard since I feel that your committe wants to get as close to the grassroots as possible, and that such direct expressions will be more valuable to you than broad generalizations.

My company, Raytheon Manufacturing Co., is one of the largest engineering and scientific oragnizations in the United States. It consists of over 2,800 engineers in a supporting cast of approximately 7,000 people, in a total count of 28,000 employees.

In short, 1 of every 10 is a creative engineer or scientist.

Our products vary from major missile systems and large radar systems to millions of small tubes and transistors. We, therefore, are involved in the majority of complex relations between the Department of Defense and industry.

In general, our efforts are characterized by a race for scientific and engineering supremacy over the capabilities of potential enemies. Every missile, every radar, every tube has to be more advanced than those of our counterparts on the other side of the curtain. This race can only be run by pushing ahead the scientific and engineering frontiers on each suceeding device.

We, therefore, must maintain a large number of extremely capable people, not only in some of the more prosaic aspects of design, engineering release, quality control, and a myriad of other production functions; but, also in the development of new concepts, inventions, new materials, and new components.

On our staff are theoretical physicists, nuclear physicists, chemists, metallurgists, mathematicians, and even bacteriologists.

Modern missiles, aircraft, and submarines require more compact equipment, performing more complicated tasks, with a higher degree of reliability at extreme temperatures. These equipments require components and materials of unusual qualities—the development of which necessarily rests on pioneering basic research and fundamental theoretical understanding of physics and chemistry.

These organized teams of scientists and engineers constitute today one of the essential bulwarks of our national defense. In fact, in this period of cold war, these teams represent a major element of our frontline and on their success rests to a large degree the ultimate victory.

Clearly the ability of industry to support such scientific and engineering organizations depends on the economic forces affecting the well-being of the individual companies. It is a basic element of our free-enterprise system that companies must be profitable to survive. They can, in fact, increase only if return on investment is sufficiently large for both internal growth and the attraction of required capital.

Let us look for a moment upon the electronics industry. This is a rapid growth industry. It consists roughly of three parts: the entertainment industry, military electronics, and the balance. The entertainment industry, TV and radio, represent about 35 percent of the total industry; the military electronics about 50 percent; and the rest including industrial controls, instruments, commercial communications, and so forth, about 15 percent.

In our considerations today we can omit the entertainment portion of the industry since it is extremely specialized and has very little interaction with the remainder. The result is that of the remainder of the electronics industry, 75 percent is Government military business.

In this regard it is not dissimilar from the aircraft industry. However, there are many differences between the aeronautical industry and the electronics industry. For example, there is no Government-supported research institution corresponding to the NACA for the electronics industry.

Instead, the electronics industry is forced to support its own basic research. Secondly, a large fraction of electronic procurement is in small packages with duplicate sources in production and competitive bidding on reorders.

In contrast, within the aircraft industry, individual companies by virtue of their Government facilities, Government tooling, and be-

cause of the character of the airplane as a product, are assured that initial production and reorders will follow development.

In the electronics business, there is no guaranty that the company which devotes its scientific and engineering manpower to a research and development project, and ties up its facilities and working capital on this same development, will end up with a production order.

It is, therefore, impossible for the management of a company to plan a supporting research-and-development program based on potential earnings from following production. This situation clearly indicates that the electronics industry must be allowed adequate profit and return on research-and-development contracts per se.

I mentioned earlier in my comments that we are now engaged in a technological race for qualitative supremacy. This has reacted upon our military forces in bringing about rapid obsolescence of equipment. There is, however, another consequence directly associated with this rapid obsolescence—namely, that the amount of production which follows any major development is relatively small.

Since the new equipment needed is more complex and has to evolve as a result of greater achievements on the technological frontiers, the development of this new equipment becomes far more expensive than it has been in the past. Similarly, because of rapid obsolescence the military departments are buying smaller quantities of these equipments. In short, the number of development contracts has increased and the amount of production has decreased.

Let me illustrate this by a typical example. The ratio of total Government engineering effort in our Government equipment division in 1957 at Raytheon as compared to the total Government production was 1 to 2.1. In short, about one-third was engineering and two-thirds production.

It is quite clear that with this large ratio of engineering to production, that the engineering portion of these projects must support their fair share of all the burdens facing the company, as well as provide a reasonable profit to sustain the well-being of the company.

Gentlemen, I wish to summarize these points by clearly stating the first conclusion that Government research-and-development contracts per se must provide adequate profits to build up strong laboratory organizations through the attraction of capital.

Closely associated with the above problems are several factors which tend to reduce the apparent fee on research-and-development contracts. These include procurement attitudes and certain disallowed costs. It has been customary in the past few years for fees on cost-plus-fixed-fee contracts, where such contracts cover research and development work, to range from zero to seven and a half percent.

Whereas, the statutes provide for percentages as high as 15 percent, the general attitude resulting from (*a*) congressional review; (*b*) the desire of the Government procurement officers to squeeze out as much as possible for every dollar; and (*c*) the prevalence of many disallowed elements, have resulted in fees ranging actually from a few percent to actual losses.

Let us for a moment reflect on the implications of this from the standpoint of our national need, namely, the support of basic research. The ASPR regulations clearly state, article 15, that general research is not allowable as an overhead charge against Government cost-plus-fixed-fee research and development contracts.

Let us look at the absurdity of this situation as applied to the electronics industry. The bulk of the industry is occupied with Government work. The ratio of engineering to production, as stated earlier, is very high. The engineering programs are largely dependent upon the basic and applied research being pursued primarily by individual electronic companies.

Yet this very lifeblood is not acceptable as an allowable cost. With margins of profits down to a few percent, if at all, insufficient money is left to be considered adequate return and compensation for general inflation, to say nothing of supporting research or paying stockholders. It is a strange anomaly that the Government recognizes that the cost of hiring personnel, training secretaries, cleaning floors, heating buildings, are all allowable costs and that the management of these can be entrusted to management provided only that they fall within reasonable limits.

On the other hand, basic research programs in industry not directly in support of a specific engineering and development contract are not allowed. To be sure, general engineering is permitted as an item of cost under certain conditions, i. e., cost-plus-fixed-fee production contracts when directly applicable to the production contract.

Allowance of cost is also permitted under cost-plus-fixed-fee, research and development contracts, provided that certain fantastic conditions are met—namely, that 15 copies describing each program of basic research be submitted to the Government, and that after each Department of the Government—this is Department of Defense—has scrutinized these programs they can certify that this type of research is truly basic in nature and has not already been contracted for by the Government in some other institution, Government laboratory, or university.

It is quite clear that these procedures have arisen from extrapolation of nonresearch experience. A parallel to these regulations would be to say that since Harvard has a professor of theoretical physics doing research in quantum electrodynamics that, therefore, no other university in the United States should have a professor doing research in the same field.

However, the facts of the case are that nearly every university of stature has more than one professor doing this type of work, and in fact so does every major industrial laboratory. What we need is many more people skilled in these scientific endeavors applying their best brain power to keep us ahead, rather than less people.

All of us gain by the general growth of knowledge which comes from the sum total advances in all laboratories, but the strength of the American industry, as it pertains to the military effort, arises from our management of large groups of integrated research teams with experts covering the spectrum from basic research and specialized skills to final product engineering.

Surely it must be quite clear that duplication in research must not be avoided. Rather, it must be encouraged and fostered in places where its impact can be immediately felt. Yet in spite of these obvious conclusions, we are faced with regulations that prohibit the proper allowance of costs for basic research in industry.

My second conclusion is, therefore, that basic research within industrial organizations should be an allowed cost against all Government contracts of all kinds, and that the tests to be applied are not those of

the detailed technical program being pursued, but whether the amount of money is reasonable and properly spent.

There are many other elements worthy of consideration by your committee, but I would rather stress these two key points than detract from them by burdening you with a lot of other considerations.

In closing, may I draw your attention to an anomaly which may face us in the future as it did back in the days of the depression in the years 1929 to 1933. At that time our universities and colleges were graduating engineers and scientists at a modest rate, but there were no jobs for these people. I can speak with feeling about this situation because, though I was at the head of my class at MIT, I received no offer and, in fact, got no industrial position.

The incentive for the schools to graduate more engineers was lacking, and the desire of the youth to invest money and years of their lives in scientific and engineering education vanished. Today we are facing a race with Russia in the training of scientific and engineering personnel. Much has been said about the need of more scholarships, more schools, more and better teachers; and indeed I wish to add my support to these advocates.

However, let us remember that such activities and funds expended on schools will be of no avail unless these graduates have a place in which to work, and unless their professional careers will bring enough of a reward that additional youth will be attracted to these disciplines.

Only industry can provide the laboratories and jobs for these newly trained scientists and engineers, but industry can do it only if the policies of our National Government are such that financially healthy organizations exist in which basic and applied research can flourish.

The two most important steps, in my opinion, to be taken immediately are:

(1) Through adequate fees, procurement attitudes, and revision of allowed costs, make Government research and development contracts sufficiently profitable to attract private capital.

(2) The cost of basic research within industrial organizations should be allowed as a cost against all Government contracts, including so-called research and development contracts, and that the tests to be applied are not those of the detailed technical programs being pursued but whether the amount of money is reasonable and was properly spent.

Mr. FASCELL. Congressman Michel?

Mr. MICHEL. No questions, Mr. Chairman.

Mr. FASCELL. Dr. Getting?

(No response.)

Mr. FASCELL. I think you have certainly presented your position very clearly, very carefully.

I have a few questions, because it seems to me that the whole theory is predicated upon the philosophy of the place of private enterprise.

I further denote through this statement a feeling that perhaps this position is changing, and we might as well face it. Now, I could be wrong in this interpretation, but that is the feeling I get in listening to your testimony, particularly when you point out as carefully as you did the fact that 75 percent of the electronics business is Government.

Now, this raises a question of the profit motive right away, and so I am forced to ask you some questions, although I think the points

you made are very material and certainly present a difficult problem for industry.

First of all, am I correct in saying that if you do not make a profit out of something, this is a contract matter?

Mr. GETTING. I would like to understand that question.

Mr. FASCELL. Well, in other words, the sale of your production capability is purely a contract matter; is it not?

You either sell it or you don't. You contract to sell it with someone?

Mr. GETTING. All right. Yes.

Mr. FASCELL. But what you are saying, in effect, as I understand it, is you have little control, because 75 percent of it is sale to the Government and no one else?

Mr. GETTING. Let me start with the statement that selling to the Government is a recognized business. It always has been.

Mr. FASCELL. Is it on the same basis that you sell to an individual or a private company?

Mr. GETTING. It is not.

Mr. FASCELL. No, sir; it is entirely different; isn't it?

Mr. GETTING. Right.

Mr. FASCELL. Now, why is it different?

Mr. GETTING. Well, it is different in a great many respects.

Mr. FASCELL. I understand that, but the question I am asking is, Why is it?

Mr. GETTING. I would like to ask, sir, if you would help me understand your question.

Mr. FASCELL. Well, Government is a major part of your business, but doing business with the Government is not like doing business with a private corporation.

In other words, it is not entirely in the competitive field; you either compete to sell what you have and make a profit, or you do not—if you are in private business, dealing with private individuals and private companies.

But what you are pointing out to us is that this is not true when you are dealing with the Government.

Mr. GETTING. If we are dealing with the Government in this class of products, we have one customer; that is very true.

Now, secondly, the statements that I am making here are in the terms that it is to our national interest to foster a greater scientific progress in the country, as a natioal potential, a national value.

Mr. FASCELL. All right, sir. Then we have to assume, with this as our basic predicate, all your conclusions; isn't that true?

Mr. GETTING. I think so, provided that you will permit me to add that as long as our country is based on private enterprise; namely, that profits attract people who invest money, regardless of where profits come from; people will invest in the direction where they get a return on their investments. To that extent it would appear to me that it was a function of Congress to help stimulate the flow of money in a direction which is to the interest of the country's well-being, in this case national defense.

Mr. FASCELL. We are appropriating an awful lot of money for national defense that goes to Raytheon and other private companies that are producing for the United States Government.

Mr. GETTING. That is true.

However, the question that I am raising in this instance is that the nature of the work which the Government is buying from at least this segment of industry has gotten to be very largely engineering, and what is normally called in the Government research and development, and that the interpretation of this allowed cost, plus ASPR regulations, plus the unilateral interpretation of such things as redetermination and renegotiation have resulted in their entirety in depressing the return on investment in this area to the point where it is more attractive for the people of this country to put their savings into making automobiles.

Now, I daresay that Congress cannot directly legislate to people where they should invest their savings and their money and their efforts.

Mr. FASCELL. Nor can we legislate, Doctor, what type of business you shall engage in.

Mr. GETTING. That is correct.

But I am venturing to point out here, sir, that Congress has sought in its own judgment to permit 15 percent fees on cost-plus-fixed-fee research and development contracts.

Mr. FASCELL. As an allowable element of cost.

Mr. GETTING. No, 15—Yes, as over allowed cost, as profit.

Yet, in point of fact, the administrative or executive departments of the Government have, to my knowledge, exercised the statutory permitted 15 percent not at all. So, I cannot turn toward Congress and say, "You have not done your task in permitting adequate fees," but I can ask whether it was the will of the Congress to bring about an economic situation in which there would be a growth of this basic supporting industry to our national effort, and suggest to you that perhaps, since you are reviewing how your legislation has resulted in performance, that you might wish to look into the fact: What are the facts?

And I am merely trying to be of assistance here by pointing out that actually, in general, the fees never exceed 7½ percent, and that by the time you take the disallowed cost, no allowance on interest, no allowance on basic research, which we must now pay out of profits, that by the time you get through, the return on investment, particularly in laboratories where the Government does not supply facilities as they do in production, when you get all through with this, you have an economic climate which is not healthy.

And this is the sole point I am raising here.

Mr. FASCELL. I understand. You have made your point very well, and we are indebted to you for being very honest and frank about the position of industry on this thing.

But, since we are reviewing it and discussing all angles of it, you are telling us about how the legislative intent is now operating, and I am taking the liberty of going back beyond the legislative intent, which brought this about to start with——

Mr. GETTING. Yes, sir.

Mr. FASCELL (continuing). Which involves the whole question of industry and Government and doing business, with Government being the biggest buyer, and what effect this has on the profit motive and on costs and on operations, and all these things, which I think you will agree is a legitimate inquiry.

Mr. GETTING. Yes, sir.

Mr. FASCELL. So we have to get back to the predicate which is that part of the basic difficulty is the fact that Government is the largest buyer.

Otherwise, you would compete on the open market for normal profits?

Mr. GETTING. That is so.

Mr. FASCELL. And you would take care of, in this type of operation, whatever engineering costs or basic research costs or other costs that are necessary to keep you in a good, competitive position; would you not?

Mr. GETTING. That is correct.

Mr. FASCELL. Now, the only change that exists over this normal type of operation are two factors, as I see it: One is that Government turns out to be your biggest buyer, and is a highly competitive purchaser. The other is, by statute, they have made a particular allowance which you are not getting by regulation as an allowable cost item.

Mr. GETTING. Excuse me. I want to be sure that we are using the terms the same way.

Mr. FASCELL. I probably confused the——

Mr. GETTING. We talk about allowable profit fee as being over, above the cost.

Mr. FASCELL. Above cost?

Mr. GETTING. Yes, sir.

Mr. FASCELL. In other words, this is set up as a separate item?

Mr. GETTING. That is correct, and I am merely pointing out that when Congress appropriated or when Congress passed a statute which permitted up to 15 percent, that, apparently, the sufficient leeway does exist.

Mr. FASCELL. Yes; I understand that. Now, what I want to get back to is: Why, in the normal competitive merchandising operation, you cannot come up with a competitive product which involves all these costs as part of your price? Now, do I make myself clear?

Mr. GETTING. Well, in doing business, we are talking about research and development.

Mr. FASCELL. I am talking about everything that goes in to operate your company. You say you have 2,800 engineers, you have to do basic research, but you make the point that you are only allowed this extra fee in cases where it is directly tied into a specific program?

Mr. GETTING. That is correct.

Mr. FASCELL. And which you say is really not justifiable under the situation because it ought to be allowable within the limit fixed by law for all basic research, whether it is tied into a specific program for the governmental purchaser or not? Do I——

Mr. GETTING. I am not sure, sir, I quite follow you. Let me try to rephrase it, sir. I was trying to formulate two basic principles. One was that the so-called research and development contracts which constitute, maybe, $1½ billion to $3½ billion, depending upon how you define the fiscal——

Mr. FASCELL. Excuse me, right there, to clarify that, you are talking about a Government contract for research and development for a specific purpose——

Mr. GETTING. Right.

Mr. FASCELL. Which would be granted to a particular company——

Mr. GETTING. That is correct.

Mr. FASCELL. On a specific project which may or may not lead into production?

Mr. GETTING. That is correct. On such a contract, which the Government has placed with industry, the buyer or purchasing agent will, generally, insist on the fee on the estimated cost of doing that task, let us say, of 7 percent, which is customary. Now, this contract may not lead into production. You may find that on completing the task you will have spent 20 percent more. Your fee is not increased and, therefore, the fee on the total amount of money spent is now about 6 percent.

Mr. FASCELL. Well, now let's stop there for just a moment so that I can get this thing clear in my mind. Is this a competitive product, research, basic research?

Mr. GETTING. This is not basic research. I am trying to stay away, for the moment, sir, if you will permit me, from basic research.

Mr. FASCELL. Right.

Mr. GETTING. Let us assume that the Government wants to buy a new type of guidance for a missile?

Mr. FASCELL. All right.

Mr. GETTING. It will contract competitively, or it will go into competitive bidding with several companies on the basis of a specification. As a result of the competition, where each company may spend either $100,000 in preparing the bid, one company is selected, whereupon the presumption is that he is elected on his promised performance and on his price. On the basis of a negotiated price or the bid price, he is permitted a fee, say, 7 percent. Let us assume, for round numbers, that he bids $1 million. This is obviously a new effort of research and development, and it has not been completely defined—it may take invention; it may take development. The contractor and the Government agree, therefore, that it cannot be a fixed-price contract, it must be a cost-fixed-fee. It may turn out that the program costs the Government, before they are through, a million and a half dollars; let's say 2 million so I will have simpler numbers. The fee is now 3½ percent, not 7 percent. The company, in carrying out this program, had to carry working capital, had to provide heat, space, light, and all the other expenses. So, we find that the company sold $2 million sales at a 3½-percent fee. However, it was not allowed interest on borrowings for the working capital; it was not allowed to charge as a part of overhead gifts to the community fund, or to the broken-down children's home around the corner, which was done essentially for public relationship. It was also not allowed to charge any basic research.

Mr. FASCELL. Well, now, you make this point very clear, and I understand all this. However, I come right back and ask you, isn't this a competitive product which you are selling, and the answer is, obviously, that it is. In other words, if you do not get this contract, some other person will bid on it?

Mr. GETTING. Yes.

Mr. FASCELL. In other words, you are selling this as well as the manufactured finished product for which you are primarily in business?

Mr. GETTING. That is correct, sir. Now, the question is: Is it the intent of our national policy to increase the strength of this scientific engineering potential, or to decrease it?

Mr. FASCELL. Well, I have to invert the question the other way and say: Is it something that private enterprise ought to undertake to do as part of its normal operation, which it should make a profit on, and legitimately so?

Mr. GETTING. I think the answer to this is that there is a role for university research—please let me emphasize that——

Mr. FASCELL. I am not getting into comparisons now, as to what the university does or the Government does; for that matter, I want to leave it strictly as far as what industry——

Mr. GETTING. Well, it has been our national character which goes back, as you know, well into our Constitution, that we would like to operate on the competitive incentive basis with private enterprise taking as large a role as possible. I think the practice, for example, with the Atomic Energy Commission, in setting up laboratries operated by industry, where, however, the profit incentive is small, but from the standpoint of management in getting it away as much as possible from too many regulatory restrictions, that these practices have shown that, in general, industry does a pretty good job.

Let me point out that today the Air Force does essentially no aeronautical research, it turns it over almost completely to industry, except for basic work of NACA. To a large extent, none of the departments of defense at present do any substantial work in electronics development. They do some, but they find it more efficient and effective to contract this work out to universities, projects like Lincoln at MIT, or Cornell Aeronautical Institution, to profit organizations like Bell Telephone Laboratories, Raytheon, General Electric, and others.

There is also the final fact—well, let me point out the arsenal system in the Army. There was a time when every gun was made in an arsenal. The Army maintained large optical shops in Philadelphia to make rangefinders and gun sights, but again the trend borne out by years of experience and results, observations of the results, even this tendency has gone back so that practically all guns are now manufactured—what guns are left—by industry. Missiles are produced by industry.

Now if you want industry to produce, then you have to give them the engineering capability, and you have to give them also the basic scientific personnel within their organization in order to make sure that the products they are making are qualitatively right up to date.

Mr. FASCELL. No one can argue with this, and everyone wants to put the proper place for industry in perspective, along with other units, universities, private institutions, Government, and so forth.

We recognize the contribution of industry.

What I cannot quite get fixed in my own mind is this: That if all of the work that is necessary for industry to be in a competitive position is included in the price of its products and Government would pay for this on the same basis as anyone else, I cannot see where we would have a problem.

Mr. GETTING. I dare say we would not, except the Government is far different from any other customer.

We do not, as a rule, open our books to the people who buy our commercial tubes. On the other hand, as you know—and perhaps you are trying to get me to state this—the Government insists on go-

ing over in great details every little expense which a company pays and will allow or disallow each of these as in its mind and in its interpretation it thinks proper.

Mr. FASCELL. All right, now, sir.

Now we are getting back to this thing which is the cost-plus contract. This is what makes it necessary for Government to do this.

Mr. GETTING. Right.

Mr. FASCELL. And industry comes right back and says, "Well, we cannot give you any other type of contract."

Mr. GETTING. In research and development contracts, I believe that this would be a universally accepted feeling.

Mr. FASCELL. So we have to live with Government coming in and looking over our shoulder and looking at the books?

Mr. GETTING. I am sure that is so.

Mr. FASCELL. Right. Now what we are talking about now is a fair and legitimate profit for the operator.

Mr. GETTING. We are, but I would again try to say that here, around this table and in these halls, we are really saying what is necessary or essential if this country wants to build up its strength. I believe that is——

Mr. FASCELL. That is, pay industry to do its job.

Mr. GETTING. Pay it adequately.

Mr. FASCELL. Right.

Mr. GETTING. I believe, even as you give assistance to farmers in certain cases, because you feel that the foodstuffs are essential to this country and to the economic strength—Congress has to, I believe, take a broad and statesmanlike view.

I'm here merely——

Mr. FASCELL. A lot of people do not think that subsidies are statesmanlike, but go ahead. [Laughter.]

Mr. GETTING. The objectives, I believe, are understood, maybe.

I am saying that I am here merely trying to help by pointing out the practices which are affecting whether this industry will grow or decrease.

As you probably know——

Mr. FASCELL. If I understand—and I am trying to nail this down, the practice of Government which is hurting industry at the present time is the one element which is by regulation and not by law. Is that correct?

Mr. GETTING. Yes, sir.

Mr. FASCELL. Which is—where is it in your statement? Adequate fee——

Mr. GETTING. Right.

Mr. FASCELL (continuing). On research and development contracts.

Mr. GETTING. Right.

Mr. FASCELL. Because there is no way to tie that contract into possible profits out of future production?

Mr. GETTING. That is correct.

Mr. FASCELL. Which means that, therefore, you must make your normal profit based solely on that contract as a salable item; and if you do not do it on that, you cannot make it up anywhere else.

This, as I understand it, is what your problem is.

Mr. GETTING. That is certainly so.

Mr. FASCELL. And the impediment is an administrative interpretation by way of regulation, which otherwise stops this; although the law allows the flexibility to pay you the normal profit?

Mr. GETTING. Yes; and I am suggesting that part of the fault lies with Congress, because, although you passed the statute, you scared everyone to death.

Mr. FASCELL. Well, true.

In other words on the expenditure of funds. And you know—we might as well put the rest of the tail on the kite, too—we have investigated a few industries that were a little bit loose about what their costs were?

Mr. GETTING. That is right.

Mr. FASCELL. Like partners that did not exist, and wives that were on the payroll, and inflated costs for inspectors who were not really there, and substandard products that were crated and greased and marked and were duds, and a few other things.

So everyone is to blame on the thing.

We want industry to prosper, and the question is: What should be the relationship between Government and industry on it?

And the question I am asking you now, basically, is this: Why do you have to have a statute which says to industry, "You are going to get paid a profit"?

Mr. GETTING. I do not think, sir, in asking for a statute

Mr. FASCELL. No, I understand you are not. This is a rhetorical question.

We have such a statute that says you shall be allowed up to 15 percent.

Mr. GETTING. Yes, sir.

Mr. FASCELL. The question I am asking is: Why isn't it practical to do away with that and put this whole thing on a competitive basis?

Mr. GETTING. Because, in general, you cannot define the product.

Mr. FASCELL. Well, wait a minute, now.

You can define it well enough so that it can be competively bid for.

Mr. GETTING. There are many anomalies in the way we do business in the engineering area—what I call "engineering" and what the Government calls "research and development."

These anomalies result from a very complex, sociological-economic system that prevails, and a decision as to where contracts are placed is not at all simple. Sometimes these decisions—

Mr. FASCELL. You mean not at all competitive?

Mr. GETTING. Sometimes they are not competitive.

Sometimes they are made because a company which is considered as a good supplier is out of work, and they are given a development contract to save this asset for the country in the future.

Mr. FASCELL. So what you are saying, then, actually, is: Business is not really purely competitive.

Mr. GETTING. It certainly is not.

Mr. FASCELL. And since the Government supplies a major part of the business, you have not only to be competitive but you have to be pretty good politicians to get it?

I mean, this is a factor of life.

Mr. GETTING. I would hesitate——

Mr. FASCELL. I am not using the word "politician" in a derogatory sense.

Mr. GETTING. I do not feel that I have the right to use that word in this audience.

Mr. FASCELL. You go right ahead. It is all right with me.

I mean, is this the fact of life that we are trying to get across; if it was purely competitive, you could go out on the open market, and the best man would get it, the man who could produce the stuff and had the best deal, and he knew that he would wind up with his profit in open market, unrestricted?

Mr. GETTING. That is right, sir. And provided that the customer would come back to him the next time if he was satisfied with the job at the price he paid.

Mr. FASCELL. Which is another way of saying that Government just is not normal?

Mr. GETTING. Well, sir, the regulatory functions in the Government, as you know, are set up to protect the people and the Government against unscrupulous activity.

Mr. FASCELL. O. K., then, we arrive at this conclusion, and that is that since it is not possible for industry to go out, on a purely open and competitive market, and by doing the best possible job, get the business, therefore it becomes necessary to go further and control the situation, which is to fix an allowability for profit to the man who does get the contract, so that not only can industry survive, but Government can get the benefit of the whole organization, the results of the whole organization?

Mr. GETTING. I will not deny that. However, I will come back and say that the interpretation of these things, the spirit with which they are exercised, will either aid or defeat the objectives of the Government.

Mr. FASCELL. Well, I quite support you in this conclusion. I do not think there is anything wrong with that. However, I sat in on a committee one time where we got into some contracts on procurement and whatnot, and by the time we went up the line, and down the line, and reached the one who made the decisions, who was some place else by this time, and went through 18 footlockers of papers and whatnot, and I am surprised that anyone would do business with the Government and still make a profit. You see, this is the thing that got me, because the very nature of Government, the complexity of it, its size, actually dictates all this. You cannot just cut it all away and say, "All right, now boys, we are going to deal just right across the board," you have 1,900 civil servants between you and the other person, all of whom have a responsibility and a job they are trying to carry out. So we have to live with this, too.

Mr. GETTING. Sir, the other point, if you will permit me to reiterate, I know it is not a question, but it is simply the question of the allowance of basic research. Dr. Furnas made quite a point that industry was perhaps the last vestige of basic research. I do not want to argue the point as to the fact that universities are certainly the best motivated to do uninhibited research, nor that nonprofit organizations have their role. But it is a rather curious thing, nevertheless, to someone like myself who has been in all aspects of the research and development, in universities, in Government, and in industry, to realize that if a company which has a mature and sound management wants to spend some money on some basic research which is allied to their respon-

sibilities as a supplier to the Government, that he is not permitted to charge that an overhead against his contract.

I might point out as an example, in our research division we have some very bright theoretical physicists. One of them has perhaps made more contribution to our knowledge of what happens on surfaces of semiconductors, than any other person in the world. He is working to understand the theoretical physical basis of what happens on these surfaces. If we can understand this, then all of us can make better transistors and better diodes, which are so essential to keep us ahead in weight and performance of our weapons. Now we feel it very essential, in our judgment as management, to put that man on a job and give him a team, and we may spend $100,000 or $200,000 a year on this. Under the present regulations, as they are interpreted, we have to take that out of profit. Now it is a long time between what this man does this year, and the results as they may come out. And as Dr. Furnas pointed out, maybe only 1 out of 10 of applied research pays off. When you get to this basic research, you do not know whether they ever pay off. And yet we feel it is essential to have that man there for a variety of reasons: (1) to help push back the barriers; (2) to jump in on a problem when his experience and theoretical physics will get us out of a tough situation; or (3) to help the Government on a consulting committee of some sort. And yet, his time we have to take out of profits.

Mr. FASCELL. Yes, but the point is you charge that man in my transistors?

Mr. GETTING. For what purpose, for commercial use?

Mr. FASCELL. Yes. I go to the store and I buy 6 transistors, and that man is in those 6 transistors.

Mr. GETTING. But the point is——

Mr. FASCELL. But the point is that is only 25 percent of a 25 percent of your profit.

Mr. GETTING. That we would like to charge a prorated amount of that to the Government.

Mr. FASCELL. Why don't you put his whole time in my six transistors, or are you doing that already?

Mr. GETTING. We are, by taking it out of profit. This is indeed what is happening. Our commercial products are bearing, in this case, the burden for the military.

Mr. POLAND. Mr. Chairman?

Isn't it true, however, that industry gets a free ride on a commercial product which is the result of research otherwise paid for——

Mr. GETTING. This statement is made very, very often, and I think——

Mr. POLAND. I know, but you would not deny it, would you, Doctor?

Mr. GETTING. I think the Government gets a far bigger free ride.

Mr. POLAND. I know, but industry gets a free rid, too?

Mr. GETTING. Well, take our situation at Raytheon. We are making missiles. We make the Hawk, and we make the Sparrow-3—probably the two best missiles in the country [Laughter], and if I can swear, I will be dammed if I can find a commercial application for either one of these things.

Furthermore, a large part of what the Government got out of Raytheon was that we had good metallurgists, we have some of the best

ceramics people, we have been working on the theory of magnetic ferrite materials, which we are not allowed to charge to the Government. So it is the Government who is getting the free ride, and it is part of the price we pay for being in business.

Mr. FASCELL. Wait a moment, don't you make a profit off these Sparrows and Hawks, or whatever they are?

Mr. GETTING. We hope to, but if you want me to quote the economic investment——

Mr. FASCELL. After listening to you and Dr. Furnas, I am convinced no one makes a profit.

Mr. GETTING. We make a profit, I am sorry.

Mr. FASCELL. I am just kidding.

Mr. GETTING. But I am pointing out, and I will repeat this, that if it is the will of the Government of the United States to win this race with Russia, you have to provide the atmosphere in which these institutions and these people in them can flourish. That is all.

Mr. FASCELL. And go one step further, the normal processes of competition in industry will not provide it?

Mr. GETTING. Doing business with the Government is not normal. It is a legislated and a regulated business.

Mr. FASCELL. And if it turns out that all industry is in the same position we are——

Mr. GETTING. Then you will have no scientists, and you will have no weapons that will compete, and in the end we will be a second-rate power.

Mr. FASCELL. Or the alternative is that all of this type of work that you are talking about will either be done by the Government and universities and other institutions other than industry?

Mr. GETTING. No, sir.

Mr. FASCELL. You do not think that is a fair alternative?

Mr. GETTING. I think that——

Mr. FASCELL. Or logical—let me put it that way?

Mr. GETTING. I think this would be a major departure from either our experience or our national political system, or economic system.

Mr. FASCELL. You mean by that, it just would not happen?

Mr. GETTING. It might happen, but it might take a very, very long time. Your biggest potential for meeting the present situation is to increase universities, to increase nonprofit institutions, increase the industrial institutions, and I am trying to funnel my ideas here to the next one. I think for two people who seem to agree, we do it very emphatically. [Laughter.]

Mr. FASCELL. You know, no thought is worth much if you cannot challenge it.

Mr. POLAND. I would like to ask Dr. Getting if he would care to comment on what Dr. Furnas has said in respect to the added expense of doing business through industrial laboratories in view of the statement that Raytheon has 2,800 engineers, and whether or not that is a part of the elephant gun to shoot a fly.

Mr. GETTING. Thank you. I think I would not want to appear in any major way to disagree with the bulk of Dr. Furnas' testimony.

I agree with him in almost all the basic things except perhaps some of those having to do with organizations of Government for doing research and development. And in this case I think what he was referring to was the fact that there is an unfortunate practice in which

the Government, the Department of Defense, finds it necessary to order a weapon system long before the basic elements of what weapon system have been developed, and in which a large empire is suddenly built to meet a crash date. This is the price of hurry.

If you take the present situation on the ballistic missiles, this was not done in the orderly, casual development in which you could develop every part carefully and scrutinize each part. It was necessary to suddenly throw together large groups of people, many of them employed uneconomically. And these things just used up money like water over a dam. And many companies will use such large programs to build up large facilities and larger staffs. There is no denying that.

There are all sorts of practices, as you are well aware of, but I do not think this statement, Dr. Furnas' statement, meant—I should not say what he meant—that there are legitimate and proper large engineering institutions such as the Bell Telephone Laboratories, the General Electric Research Laboratories, and I would say smaller than those, too, but nevertheless significant: Raytheon Manufacturing Co.

Mr. POLAND. There are two other matters I wish you would comment on.

What is the relative advantages and under some circumstances of the negotiated versus open-wide, competitive-bid contracts, and the other, the disadvantages that you encountered due to stop-and-go and noncontinuance procedures?

Mr. GETTING. Well, in regard to the first one, if the committee would please not hold me down to the specific naming of the situation, but if I can use it as an example, nevertheless——

Mr. FASCELL. By all means.

Mr. GETTING. There was an instance recently where one of the services decided that within the country there were three companies equipped by experience, by engineering staff, by management, to undertake a very large development, and it was through management review, it was thought, possible to select one; and that this would be the most economical way of selecting. This seemed extraordinarily intelligent.

However, it is the nature of our way of doing things—and I am not criticizing anyone specifically—but using an example, 17 companies insisted that they be permitted to also bid because, in their opinion, they thought they were qualified, and I am sure in their opinion they needed the work.

This was about the time of the—well, call it as you will, the shortage of cash in the last 3 months of this last calendar year. Many companies were beginning to get quite desperate.

As a result, about 15 companies bid, and I would estimate that the average cost per bid was of the order of $100,000, which would mean $1.5 million, and that this occupied some of the best brains in those 15 companies, because now you are in competition on ideas, and you have to put your best people on ideas.

So a million and a half dollars was spent, and this representing some of our best manpower, in arriving at the conclusion which, apparently, I think, was made anyway by the people who started it but who were forced into this procedure.

Now, if I could suggest to you a better way of doing it, I would.

Frankly, I do not know. It may be that our way of doing business between the Government and industry is bound to be inefficient when it comes to competitive bidding and permitting anyone who has a reasonable right to ask for an opportunity to bid.

Mr. POLAND. You would urge a substitution of a negotiated bid in place of that process in a situation of this kind?

Mr. GETTING. I would suggest that when elements of the Government which are in the procurement of research and development make negotiated contracts, that they not be crucified per se but that they be permitted to make the negotiated contracts when they have sufficient evidence to indicate that the Government would be better served by so doing.

In other words, I would hate to see a situation in which research and development would be determined by competitive bid based on dollars alone, because there is a wonderful exercise going throughout all industry which I call the "liar's game," where, if you want a job at a cost-plus-fixed-fee, you bid low with the object of getting the job, knowing that the cost was going to be much higher, and you just take the cut in fee because you want to get into the business, or you have the facilities that were not being used.

There are many such practices. This is the fault of industry. They exist, and that is all I am saying.

Mr. FASCELL. Well, this R. and D. type of thing is subject to pure competitive bidding?

Mr. GETTING. Yes, it is.

Mr. FASCELL. Can it be evaluated other than by price?

Mr. GETTING. Very often the procedure that is used in our Department of Defense is that the Technical Branch will submit a purchase request through a procurement branch and specifications of the work to be done or developed is part of the exhibit.

Industry then quotes, and the technical part of it is examined by the technical people within the services, who generally will class these in a first, second, third, or fourth, or will say that these 3 are all competent and there is not sufficient reason for selecting 1, 2, or 3.

It then generally goes to the equivalent of a procurement committee, which will make the choice, generally, on price. So, very often, contracts are given for development on price, rather than on a technical evaluation of the skills and ability of the company, or whether they have the people on the staff at that time to do the job.

Mr. FASCELL. Are the specifications sufficiently developed so that you can evaluate on price alone?

Mr. GETTING. It depends on the program.

You see, R. and D. covers everything from an improvement on an existing unit to a breakthrough.

Mr. FASCELL. But it is not analogous to a situation of a general contractor bidding on the construction of a building wherein he has plans and "specs" to bid on, and all the person who is evaluating it has to do is to determine whether or not the stuff supplied will meet plans and "specs" and the price is competitive?

Mr. GETTING. Exactly what you said, sir.

Mr. FASCELL. In other words, it is an entirely different situation; isn't it?

Mr. GETTING. Yes, sir.

Mr. MICHEL. I think by that comment, too, Mr. Chairman, you point up the problem we face as Members of Congress in appropriating.

We have to condition the people's minds as to what this whole idea of research is. It is easy to appropriate for a tangible item, but here we are supposed to be coming up with funds for the intangible, that which we cannot foresee but we hope to accomplish by people such as you, Doctor, and your associates working as you do from day to day to come up with some new breakthroughs, new ideas.

I think you have certainly expressed your point of view very well this morning, under the sharp and cutting interrogation of our chairman, and I think he, too, has made some very telling points of what our obligation as not only committee members particularly on this Government Operations Committee, but Members of the Congress, in satisfying the wishes of those people back home who look to us to account for each one of those dollars spent.

Mr. POLAND. I was just going to ask one further question, Mr. Chairman, the second part of the one I suggested:

Do you experience any difficulty due to discontinuity in your contracts due to suspension of payments, stop-and-go?

Mr. GETTING. Well, I think the industry is not nearly as hard hit. Well, let's say the larger companies were not nearly as hard hit by this recent affair as were small companies or universities.

In our own case, we received letters that we thought were not legal, arbitrarily cutting our contracts, contract prices.

We were asked to delay our programs. We were asked to cut down on hours of work. And there were certain programs in which we were indicated "Continued funding" which were of a research type, which just were not supported.

One contract in particular, where we expect to recover a quarter of a million dollars between July 1 and the end of this month, was a program that had been sponsored by all 3 services as being of basic importance to all 3, which came under the cut of the research funds.

We have continued to carry that program, and this $250,000 has come straight out of profits. We are at the moment approaching the services to see whether they will allow a broader interpretation of the recoverable cost clauses. We have no indication that they will. We are hoping that the general tenor of the times, plus the attitude expressed by Congress, will permit recovery of these moneys; because I am perfectly certain that this work is of importance to the United States, and that the same situation exists in other companies, and in the end we are biting off our noses to spite ourselves.

We could have fired all these people, put them out on the street. If we had fired them, put them out on the street, like some companies were forced to do, even in our area, you would have had a technological unemployment of your engineers and scientists. This would react on the boys who are now in high school and who are making up their minds as to what career they are going into. And if they choose some other career, then obviously this reacts on the thing which we are trying to determine here, what do we do to get ahead of the Russians. So we chose to ride out the storm and take the cut in our profit. And I think we were wise in doing so, and I think that the situation is now going to improve.

Mr. FASCELL. Any other questions?

Mr. LANIGAN. Just one. To what extent can you make up on a later contract a loss, say, in research on an earlier contract? Is that ever taken into account in negotiating later contracts?

Mr. GETTING. I know, sir, you cannot offset losses on one contract as against another.

Mr. LANIGAN. That is not done formally or informally?

Mr. GETTING. We live in a glass bowl. We have Government accountants all over the place, inspectors all over the place. If we have an overrun on a project, or if we have some expenses that were not recovered, we cannot hide this in any known way. In a big public corporation like ours, the books are quite open——

Mr. FASCELL. Is it excludable from taxation income?

Mr. GETTING. Yes, it is a loss. It just is not income, it is a loss. I think we are at the present time talking about a net loss at Raytheon in the order of $3 million in the last calendar year of unrecovered, what I would call basic and applied research.

Mr. FASCELL. And what you are telling us is that this is large enough so it cannot be made off of the other business of the company, that is, the private business?

Mr. GETTING. Well, the company will be in the black——

Mr. FASCELL. I understand.

Mr. GETTING. But the amount of black is too little to make it very attractive to you to buy an awful lot of stock unless you think something is going to happen. They would rather put it into a commercial product. And I am off commercial products, but again I come back with: What is our national policy?

Mr. FASCELL. I understand. But I want to get clear whether or not this amount of loss, or any loss, can be transferred completely over to the private part of the business and still make a substantial profit, enough to attract capital?

Mr. GETTING. Not at the present ratio. It varies with companies. There are some electronic companies that are 100 percent Government. In the case of Raytheon, we are 80 percent Government and 20 percent commercial.

Mr. FASCELL. I do not see how you can stay in business.

Mr. GETTING. It is the nature of the business. You can look at our financial statements and you will see. We are competing in our commercial products, for example, in our marine line where we are the biggest manufacturers of the world of marine radars, ship-to-shore communications, and fathometers, and yet we are competing with DECCA in England and other companies abroad in a competitive market. So we cannot load these products and sell and keep our employment for this country up—by loading all these charges against that. We have to, therefore, take this basic research as a loss after all——

Mr. FASCELL. Unless you do not do any Government business?

Mr. GETTING. We do Government business. We are in the business, and we are saying again, we would like to make more money off the Government. If we make more money, we can do a better job.

Mr. FASCELL. And then, you have the people around that Government needs?

Mr. GETTING. Yes, we have the people that the Government needs.

Mr. FASCELL. Right. Of course, you still cannot eliminate the basic premise which is you do not have to go after this Government business

to make a profit. This is a problem which we all have to wrestle with, you see.

Mr. GETTING. That is right.

Mr. FASCELL. But if we do have the Government business, then it ought to be on the basis where the company that gets it can make a fair share of the money. I agree with that.

Any other questions?

Dr. Getting, I thank you very much for your patience and testimony presenting your position before this committee.

Mr. GETTING. Thank you, sir.

Mr. FASCELL. It is certainly a new angle that I had not considered, and am very happy to learn about it. Perhaps we can do something with it.

(Whereupon, at 1:10 p. m., the subcommittee adjourned.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

MONDAY, FEBRUARY 3, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND LEGISLATIVE REORGANIZATION OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10:10 a. m., in room 1501, New House Office Building, Hon. John W. McCormack, presiding.

Present: Representatives McCormack (presiding), Fascell, Granahan, Harden, Meader, Brown, and Michel.

Also present: Orville S. Poland, general counsel to the committee, James Lanigan, associate general counsel; William A. Young, staff consultant, and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK. The subcommittee will be in order.

Mr. Michel and I and all of the other members of the subcommittee present and absent are very glad to welcome one of our very capable members of the full committee, Mrs. Granahan, of Pennsylvania, and we are particularly pleased to note that the chairman has made her a member of the subcommittee.

We are very glad to have you with us, Mrs. Granahan.

Mrs. GRANAHAN. Thank you, Mr. McCormack.

Mr. MCCORMACK. I understand the first witness today is Gen. Alfred D. Starbird, Director of the Military Application, Atomic Energy Commission. We are very glad to have you with us, General Starbird, and we will be glad to hear from you.

STATEMENT OF BRIG. GEN. ALFRED D. STARBIRD, DIRECTOR, MILITARY APPLICATIONS DIVISION, ATOMIC ENERGY COMMISSION; ACCOMPANIED BY CAPT. EDWARD E. CONRAD, MILITARY APPLICATIONS DIVISION; DR. SPOFFORD G. ENGLISH, DEPUTY DIRECTOR, DIVISION OF RESEARCH; LOUIS H. RODDIS, JR., DEPUTY DIRECTOR, DIVISION OF REACTOR DEVELOPMENT; AND DR. CHARLES L. DUNHAM, DIRECTOR, DIVISION OF BIOLOGY AND MEDICINE, ATOMIC ENERGY COMMISSION

Brigadier General STARBIRD. It is a great pleasure for us to be here, sir.

If it pleases you, I will proceed with a written statement that I have prepared that I think will provide a vehicle for your further questions. That statement will take about thirty minutes.

I would like to identify for the record the other members of the Atomic Energy Commission who are here with me.

First, there is Mr. Louis Roddis, who is the Deputy Director of the Division of Reactor Development.

There is Dr. Dunham, who is Director of the Division of Biology and Medicine, and there is Dr. English, who is Deputy Director of the Division of Research.

The staff of your committee already has had discussions with certain members of the Commission's staff. On the 22d of January, the chairman, Mr. Dawson, wrote to Admiral Strauss making reference to these discussions. His letter pointed out that there had been no overall testimony given to the subcommittee proper. He stated that it would be helpful to the subcommittee to receive the testimony of one or more representatives who could speak on the nature and details of the relationship between the Commission and the military departments in the field of scientific research and development.

It is our purpose today to give that testimony. I shall give an initial overall description which will require approximately 30 minutes and shall use certain charts in so doing. In this I will be assisted by Captain Conrad, one of the members of my division.

In my description I shall cover four factors relating to the question given to us and in the following order:

First, a very short description of the important legislative history applying to the division of responsibility between the Atomic Energy Commission and the Department of Defense in their related research and development fields.

Second, a little on the organization of the Atomic Energy Commission and how it carries on its research and development functions.

Third, a description of the essential points in the Department of Defense organization which relate to the Atomic Energy Commission's research and development.

Finally, and in some detail, how individual requirements are placed by the departments of the Defense Establishment on the Commission and the manner in which coordination is achieved as the work progresses.

I hope, sir, if there are some questions that you have, you will interrupt as we go along. We may speak in too technical terms, and it might be well that any term not understood be explained before we go further.

Mr. McCormack. Would any member desire to ask a question while General Starbird is testifying? It is a fine suggestion because it makes the questions in continuity with the particular parts of your testimony.

May I ask you, General, are you connected with the Atomic Energy Commission or the Department of Defense?

Brigadier General Starbird. Sir, I am a Regular officer of the Department of the Army, assigned for a period of time to the Commission as the Commission's Director of Military Application. The law calls for such a Director, and provides that he must be a member of the Regular Establishment of the Department of Defense. However, while working for the Commission, I am responsible only to the Commission and am, therefore, a staff officer of the Commission and not of the Department of Defense; does that answer your question?

Mr. McCormack. Who pays you?

Brigadier General STARBIRD. I am paid in part by the Department of Defense and in part by the Commission.

Mr. MCCORMACK. Are you on active duty, General?

Brigadier General STARBIRD. I am on active duty, sir.

Mr. MCCORMACK. Do you have any questions, Mr. Michel?

Mr. MICHEL. Your tour of duty is for how long?

Brigadier General STARBIRD. Three years, normally, sir, with the right of the Commission to extend it a year if the Commission so desires.

Mr. MICHEL. The Commission has the right, rather than the Secretary of Defense?

Brigadier General STARBIRD. That is correct, Mr. Michel.

Mr. MCCORMACK. You mean the Atomic Energy Commission?

Brigadier General STARBIRD. The Atomic Energy Commission, sir. We normally speak of the Commission, and, whenever I use that word, I am referring to the Atomic Energy Commission, sir.

Mr. MCCORMACK. Doesn't the Army have the right to assign you elsewhere?

Brigadier General STARBIRD. No, sir; the agreement with the Commission is that I will be made available to the Commission, those before me and my successors, for a definite period of time, with the right to extend on the part of the Atomic Energy Commission.

Mr. MCCORMACK. That is rather an exception, isn't it?

Brigadier General STARBIRD. It is, sir. On the other hand, unless it was agreed that an officer sent over in my function could stay for an indefinite period of time, his usefulness would be lessened. After all, the Commission's business is carried on largely in this field on a need-to-know basis, and, unless the officer has a chance to get in and learn the know before he really goes to work for them, if there were a question that he could be pulled on a moment's notice, his usefulness to the Commission would be decreased.

Mr. MCCORMACK. The thought I had in mind when I asked the question—I will ask it directly. Do you think it might be an advisable policy for the branches of the armed services to establish a permanent policy division or corps of technological men, or whatever you want to call them, where they could devote their whole career to it and, coupled with that, the recognition of their services, of their importance, and the opportunity for advancement, which is an important thing to anyone's life? On that broad observation or, in the nature of a question, if you want to call it that, would you have any comment to make?

Brigadier General STARBIRD. Sir, I think your suggestion is a good one, and I think most of the services have already adopted, within the very recent years, a policy of selecting certain individuals, giving those individuals special schooling, and then keeping them, generally, on assignments where they are connected with atomic energy and research and development related to atomic energy.

Now, it was not possible, generally, throughout the World War II years, to pull officers and send them to school. After World War II and up to the Korean campaign, they sent a great many younger officers to take special schooling. Korea interrupted this. However, the policy was resumed again after Korea. So, we are getting, now, a large number of highly qualified technical officers in all of

the services who can have assignments where they are extremely familiar with the research and development that is going on.

Mr. McCormack. Well, I sat with the Riehlman committee in 1954. You are acquainted with that?

Brigadier General Starbird. Yes, sir.

Mr. McCormack. And, of course, one of the fields where we entered were those conflicts—trying to reconcile divergent groups into an effective team, so we could get the maximum results for our Government. You remember that. Has there been any improvement in that?

Brigadier General Starbird. I am not familiar with the details, sir. I can tell you that there certainly has been improvement in the coordination of scientific efforts and the development of people who are scientifically and technically trained within the services.

Mr. McCormack. All right, General; I may ask you some more questions later on.

Are there any other questions by any members at this point? All right, General.

Brigadier General Starbird. Going first, then, to the first of the factors I mentioned, the legislative division of responsibilities of the Atomic Energy Commission and the Department of Defense. As you know, the early effort by the United States in developing atomic energy for military application was carried forward entirely under the direction of the War Department and through that Department's supersecret Manhattan Engineer District. With the end of World War II, the Congress enacted legislation to establish the civilian-controlled Atomic Energy Commission and to place therein many functions and responsibilities held earlier only by the Manhattan District. That act, the Atomic Energy Act of 1946, described in detail the functions of the Commission. It assigned to the Commission functions of interest to us here today, as follows: First, responsibility for conducting research, development, test, and production of atomic warheads and bombs; and second, responsibility for conducting or having conducted research on utilization facilities—and by utilization facilities I mean some piece of equipment which can use atomic energy—and other applications of atomic energy, whether for military or civilian purposes.

Later, many features of the act of 1946 became somewhat outdated. Peaceful applications had progressed much faster than expected in 1946. Several atomic devices were fired by the Soviets. Therefore, a major revision in the statute was enacted in 1954. This revised statute gave greater emphasis to peaceful development of atomic energy. It provided for wider declassification of information, and distribution of unclassified and classified information, to some extent, outside of Government in furtherance of peaceful application. It permitted certain cooperation with friendly nations abroad in the furtherance of peaceful uses, and a more limited but valuable cooperation with allies to increase our overall defense posture. Yet, in spite of greater emphasis and measures to facilitate peaceful development, the act, in its declaration, findings, and purpose, stated:

> a. the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security.

Importantly, the new act changed very little the division of responsibility as between the Commission and the Department of Defense in the fields of military research and development. The Commission was charged still—

> to conduct experiments and do research and development work in the military application of atomic energy; and engage in the production of atomic weapons or atomic weapons parts * * *.

On the first look, then, it would appear that the arrangement dictated by the original and 1954 acts was to be one wherein the Department of Defense need only state a requirement and thereafter receive the hardware when, and as, produced. It would appear that the coordination need be little except to insure that the requirement was simply stated and could be understood and carried out by the Commission. Yet nothing could be further from the truth. In reality, the coordination must be of the closest nature.

In the weapons field, bombs and warheads must be delivered by bombers and missiles. The Commission has no responsibility for conducting research on or developing or producing these carriers. Bombs must be capable of being carried, delivered, and monitored by the bomber. In the case of warheads, the warhead itself must be fitted into, and made to fire by, the Department of Defense-developed carrier.

In the reactor field, military reactors must fill the need of, and generally fit into, carriers which only the Department of Defense develops and builds. Nuclear submarines and nuclear aircraft are prime examples in this regard.

In he field of basic (as contrasted with applied) research there must be the closest coordination. The Department of Defense must have an appreciation of what may be possible in the future. The Commission's laboratories, particularly in view of the overriding priority, which I have already read, given by the act to common defense and security, must constantly keep in mind developments which might aid our defense. There must be coordinated effort and free interchange of information between Commission research agencies, Department of Defense laboratories, and defense planners.

Mr. McCormack. Is there, General?

Brigadier General Starbird. There is, sir, and I will come to that in more detail in a moment, sir. We have very close coordination, the closest, in fact, that I have ever seen.

In the specific research field of nuclear biology and medicine, the Department of Defense must know as precisely as possible the latest information on the effects to be expected from all nuclear phenomena. It must know the means of measuring, ameliorating and treating the effects of these phenomena. Much of the important information in this regard has had to be derived from experimentation at nuclear tests, for it is only here that there were large-scale nuclear reactions. Here, for effects close to the explosion, Department of Defense agencies have taken a significant role in developing information which is important both to military and peaceful applications of atomic energy. The Commission has, of course, taken the foremost role in most other studies; those at long range from detonation, the more theoretical approaches and studies of worldwide fallout are examples of these. It is necessary though that the Department's fine analysis be fitted with the Commission's more comprehensive examinations if duplication is

to be avoided and the greatest achievement gained in this very important field.

Mr. McCormack. In the field of biology the Commission confines itself to nuclear biology and medicine?

Brigadier General Starbird. Yes, biology and medicine as affected by any nuclear reaction or nuclear material or results from nuclear reaction.

Mr. McCormack. Not the broader field?

Brigadier General Starbird. No.

Mr. McCormack. That wouldn't include the chemical?

Brigadier General Starbird. It doesn't go into the biology and medicine in a chemical plant or the undesirable effects from a chemical plant. It holds itself entirely to matters dealing with the Commission's responsibility, the Commission being responsible only in the atomic energy field.

Mr. McCormack. But the broader field of biology and chemistry, the extensive research into the broader field of biological and chemical fields as well as maybe others, radiology and psychology, but I will confine my question to biological and chemical, it is a matter of vast importance, too, isn't it?

Brigadier General Starbird. Perhaps you would like to have Dr. Dunham's answer on this because he is, after all, the director of the activity in the Commission.

Dr. Dunham. If you are speaking solely in terms of our activities relating to the Department of Defense, they are very largely the effects of radiation from nuclear weapons. We also have a small program in the thermal effects of weapons and in the blast effects of weapons.

In the broader field of science, we have a program utilizing the tools of atomic energy. For instance, in the diagnosis, study, and treatment of cancer. This gets us into the peaceful applications of nuclear energy and its byproducts. Does this help clarify the point?

Mr. Poland. Mr. Chairman, I was going to ask how the biological effects on civilian populations in the event of nuclear disaster are determined for the use of the Civil Defense Administration.

Dr. Dunham. The Atomic Energy Commission has a rather large responsibility in this field to develop information which would be of value to the Federal civil defense agency, and in my office I have a branch called the Civil Defense Liaison and Civil Effects Branch, which assists both in the development of the information and the transmission of this information to the Federal civil defense agency.

Mr. Poland. Is that a function which is delegated by the Administrator of Civil Defense to the Atomic Energy Commission? He has the power of delegation, as I recall.

Dr. Dunham. Yes. I am not certain whether that particular function has been specifically delegated, as it has, for instance, to the Department of Agriculture and for certain aspects to the United States Public Health Service. I will try to get that answer for you.

(Subsequently Dr. Dunham supplied the following information:)

There is no Federal Civil Defense Administration delegation to the Atomic Energy Commission.

Mr. POLAND. Your recollection is that part of these biological aspects have been delegated to Agriculture and Health, Education, and Welfare?

Dr. DUNHAM. That is in the overall civil defense field.

Mr. POLAND. But we wouldn't ask you to answer those questions. We will get to those later on.

Brigadier General STARBIRD. In that connection, in each of our series of tests there sometimes is a fairly small group of very authoritative people out of FCDA. In the case of tests here in the United States, very large both top level and working level groups participate in the actual test series, securing information that they need and informing us as to other information that they may need in the future or can get from that series.

Mr. POLAND. So your liaison is with other departments and agencies than the Department of Defense?

Brigadier General STARBIRD. Yes; it certainly is.

It is apparent, therefore, from this short description that scientific research and development cannot proceed in isolation within the Commission or the Department of Defense. It must proceed in close and harmonious cooperation and to some extent in parallel within the two agencies. It certainly must proceed so that each agency knows in full what the other is doing, and without duplication between the two. This requires, then, a definitive understanding as to the division of responsibility between the two agencies, and an organizational structure to insure that all the musts that I have just mentioned are met.

Now, I believe it appropriate, therefore, that we look at the organizational structure of the Commission. I have prepared this schematic diagram. It is very schematic. It is on the easel toward the window.

The Commission and its General Manager have in Washington several Divisions, as shown on the wall chart. These Divisions have a functional responsibility rather than a regional one. Several of these, those boxed in black, have no operating responsibility. Let me read off the exhibit the designation of those abbreviations. The Divisions concerned are the Division of Organization and Personnel, the Division of Finance, the Division of Classification, Licensing, and Regulations, the Division of Construction and Supply, the Divisions of Information Service, of Inspection, of Intelligence, of International Affairs, of Nuclear Material Management, and of Security,. That is to say that these Divisions have no direct field operations, have no direct responsibility for program accomplishment, and do not spend significant funds. The other Divisions, those boxed in red, are operational agencies. These direct and supervise for the Commission the AEC's field activities. Each is headed by a Director responsible to the General Manager and the Commission for the accomplishment of a specific field of activity no matter where that activity is geographically.

These six are the Division of Reactor Development, the Division of Raw Materials—and by raw materials I mean the ore which is taken out of the ground for conversion into enriched material in some form—the Division of Production—this is the Division which takes the material, the ore, and converts it into nuclear material which is useful—the Division of Research, the Division of Military Application, and the Division of Biology and Medicine.

The Commission's research and development functions are carried out in part in its major laboratories. There are seven such laboratories, sometimes called national laboratories, each built and financed in full by the Government and operated by a qualified civilian organization as a prime AEC contractor. These are:

Argonne National Laboratory, Chicago, Ill.; Brookhaven National Laboratory, Long Island, N. Y.; Oak Ridge National Laboratory, Oak Ridge, Tenn.; University of California Radiation Laboratory, Berkeley, Calif., with an offshoot of the Berkeley Laboratory at Livermore, Calif.; Los Alamos Scientific Laboratory, Los Alamos, N. Mex.; and Ames Laboratory, Iowa State College, Ames, Iowa

These seven laboratories are considered as prime laboratories of the Atomic Energy Commission. The research and development work which they do is to a large part performed as directed by the Commission. However, the three laboratories at Argonne, Brookhaven, and Oak Ridge also participate in research work in coordination with various universities throughout the country. The other four of these laboratories I have mentioned are more exclusively concerned with work of the Atomic Energy Commission, and this particularly applies to the laboratories at Los Alamos and Livermore which mainly conduct research and development work in the weapons field.

I would like to revert for a moment now to the chart. The chart shows certain of these laboratories connected by a dotted line with one of the several divisions. That dotted line, incidentally, is the administrative line. It is the line in which contracting is arranged. However, the laboratories concerned usaully work for several of the divisions, carrying out activities in several different fields. Let me explain by an example. The Berkeley Laboratory, for example, works primarily for the Division of Research. It is the laboratory where high-energy physics is a specialty. The Berkeley Laboratory also works in part for the Division of Biology and Medicine. It does little work for the Division of Military Application. The Los Alamos laboratory works perhaps 80 percent for the Division of Military Application. However, it will work about 15 percent of its effort for the Division of Reactor Development, and another 5 percent of its work would be devoted to biology and medicine. I make these remarks only in clarification to illustrate that the line is an administrative line and does not represent a functional tie.

Therefore, it may be said that of the 7 AEC laboratories which I have listed, the 3 more often called national laboratories, i. e., Oak Ridge, Argonne and Brookhaven engage in broad programs, while the other 4 laboratories engage in more limited programs.

In addition to these principal laboratories, there are other laboratories, either partly or wholly owned by the Government, doing research and development for the AEC under contract. The following laboratories are included in this category: I might say that only a few of these are shown on the chart, primarily the larger of the several in this category. The ones there shown are:

Knolls Atomic Laboratory, Schenectady, N. Y.
Bettis Plant, Pittsburgh, Pa.
Mound Laboratory, Miamisburg, Ohio
National Reactor Test Station, Arco, Idaho; and
Sandia Laboratory, Albuquerque, N. Mex.

Mr. McCormack. Are there any in New England, General?

Brigadier General Starbird. There are a great many contracts in New England. There are several of yours up there. Do you want to mention which they are, Mr. Roddis?

Mr. Roddis. The principal activities which we have in New England are at Massachusetts Institute of Technology. We have extensive contracts, although not a major laboratory. The Firm of Nuclear Metals and the Firm of Metals and Controls are both in Massachusetts. I don't know whether you include New York in the New England area or not. The Knolls Laboratory and the Brookhaven Laboratory are both in New York State.

Mr. McCormack. They are a good part of the United States if we could get away with it.

Have you got one at Winchester?

Mr. Roddis. There is a small one of the Raw Materials Division; that is, the Division of Raw Materials has a small process development laboratory which is actually in Winchester.

Mr. McCormack. Is that operated by the Commission?

Mr. Roddis. It is operated by a contractor for the Commission to the account of the Commission.

I can supply that for the record, sir. There is nobody from the Division of Raw Materials here. I just don't know the contractor. Perhaps I can find it in here.

Brigadier General Starbird. We will return to that, sir.

Mr. McCormack. There was a rumor they are going to close it. I was rather interested from that angle, too.

Mr. Roddis. I don't know about that, sir.

Mrs. Harden. I might add they do close them because they closed the Dana plant in my district.

Brigadier General Starbird. And you expressed a tremendous amount of interest in that plant, Mrs. Harden. I remember when you came to the Commission.

This second category of laboratories, all contractor operated, are engaged in specific programs of the Atomic Energy Commission in the weapons and reactor fields. They are usually more in the nature of applied engineering rather than basic or fundamental research.

Mr. Roddis. I can supply the material for the record now, sir. You are speaking of the Raw Materials Laboratory operated by the National Lead Co. in Winchester, Mass. It employs approximately 40 scientists and engineers and 80 other personnel; total plant investment of the Commission is slightly over a million dollars.

Mr. McCormack. You can't give any further information.

Brigadier General Starbird. There is a third category of laboratories which we normally call works laboratories. These are located at production plants of the Commission and are aimed at improving the operation of manufacturing facilities at the plants where they are located. Such so-called works laboratories exist at Hanford, Oak Ridge, and Savannah River.

Each of the Program Divisions also accomplishes certain of its work by contract with civilian laboratories or other nongovernmental agencies. Only in rare cases is the Commission's research and development accomplished in Government-staffed organizations. Let me hark back a moment to each of the boxed red divisions and de-

scribe in brief its research activities and, if major, where accomplished.

First, the Division of Raw Materials, the Division of the cycle in the nuclear material chain, directs the actions of the Commission relative to the developing of the mining and milling resources needed for the production of special nuclear materials. Research here is on a minor scale. There is, for example, the laboratory in Winchester, a small laboratory in Grand Junction, and a pilot line at Grand Junction.

The Division of Production takes the processed ore and, by reactors and diffusion plants, converts that ore into usable special nuclear materials—enriched uranium and plutonium. Research here is a very important effort. It is an effort devoted to process improvement, however, and is not of direct bearing to our relationship with the Department of Defense.

The Division of Research directs its efforts primarily toward the conduct of basic research (again as contrasted with applied research). It does this in a large part through our national laboratories. In great part, however, it does this through contracts with civilian organizations, particularly commercial laboratories and universities. In this latter regard, for example, it is carrying on activities under approximately 350 separate contracts.

The Division of Biology and Medicine, which is the Commission's agency for determining the human and other environmental effects to be expected from nuclear reactions, also conducts a large portion of its work through the national laboratories. In addition it has approximately 500 separate contracts with civilian agencies.

The Division of Reactor Development, which executes all of the Commission's work directed toward reactors (both civilian and military), carries out a major portion of its effort in the national laboratories. It also, however, administers a rather small number of large contracts with civilian industry in which research and development is a primary purpose.

The Division of Military Application carries out the Commission's responsibilities for the research, development, test, and production of weapons. In the interest of security a very large portion of the work is done in 2 nuclear laboratories and in 1 very large, contractor-operated, Government-owned, nonnuclear laboratory. For its production of weapons (though production is not of direct concern to our present problem) it uses many prime contractors in Government-owned plants and innumerable procurements from commercial sources.

In our future discussions we need concern ourselves only with the relationship of four divisions I have mentioned and with their counterpart activities in the Department of Defense. These four are the divisions that carry out the major part of the Commission's research. They are the Research Division, Division of Biology and Medicine, Reactor Development Division, and the Division of Military Application.

Now, looking toward the Department of Defense, let us now look here at the agencies which have responsibilities which must be keyed with the Commission. Here my diagram is a simple one. I have made it excessively simple so that I might point up rapidly the various agencies of major concern to us. For ease in showing the primary agencies in this regard, I have colored on this second schematic chart the Department agencies concerned. Here I have used:

Black to denote an agency primarily concerned with developing a requirement—finding a way of better using atomic energy to promote our defense.

Blue signifies an agency concerned with screening—establishing that the requirement is real and need be met. I do not necessarily mean the eliminating, but the screening to eliminate the things that aren't necessary and screening to firmly establish a requirement if there is in truth a requirement for that particular application.

Red on the chart is used to designate an operating agency, one which carries on and coordinates its work with us so our joint effort can progress in harmony.

First, in the Department of Defense there are three departments, each of which has its planners who are attempting to determine how to best use nuclear energy and other means for improving the service capability. These work with and visit, almost on a continual basis, the AEC's research agencies—our laboratories and contractors. Their liaison is not formal but it is constant. By almost continually I mean that there is hardly a day that some of the planners are not visiting our research laboratories or our other operated contract research agencies. These planners are always seeking ways of promoting their capabilities—as we would hope and expect. There is, without doubt, competition in this regard to find a new use first.

Requirements, then, for new developments originate generally with the services themselves. Here the planners, getting wind of some new possibility, build this up into a new hope—something that will be more efficient or more effective. They plan out how the hope might be converted to reality—the time scales, the uses, and the means required. Enthusiasts press hard to have this recognized as something the AEC must do—and usually with top priority.

Secondly, we have on the chart again in black but also in blue, using the two colors, the Joint Chiefs of Staff who receive the requirements which are developed by the three military services and work out to some extent overall requirements from the individual services' stated needs. Requirements of certain sorts originate, too, in the Joint Chiefs of Staff, but those not already pressed by the services are few. The JCS, then, is both a requirements and a screening agency, but largely directed toward requirements. This is natural because it is the planner and is charged with carrying out the defense of the Nation. It lends impetus to new applications, weapons or power uses, which it believes important. Also, it attempts (particularly in the weapons field) to order the requirements into a priority and to idicate when these are needed. It gives little attention to basic research.

Here reading that sentence, I think it is too blunt. It is not as I intended. What I mean by that, they are focused on something that has basic research and is coming into a stage of application. Naturally they keep themselves familiar with basic research, but they expect the services to watch more carefully the basic research and come up with new applications when such new application appears appropriate.

Considering its responsibilities this is natural. Its interest is focused on developing plans which have a high probability of success—plans which use hardware which is "promised" rather than "hoped."

It is at the Defense Department level that the real action is centered. This is screening of requirements. To screen requirements and to

order them to the realities of competing demands (laboratory and fiscal). Here there is an Assistant Secretary of Defense for Research and Engineering who advises the Secretary of Defense on what requirements need to be called out to the AEC and when the new applications are really needed. He is assisted by a Coordinating Committee on Atomic Energy—a committee chaired by a senior assistant to the Assistant Secretary and having general-officer rank representatives from the operating and research sides of each service.

Finally, there is the requirement and screening chain—a rather unique agency, called for both by the 1946 and 1954 acts, the Military Liaison Committee. This is an agency chaired by a Presidential appointee and having senior representation of all three services. It is an agency charged with looking:

First, toward the Atomic Energy Commission to see that the AEC's efforts make greatest contribution to defense and security; and second, toward the Department of Defense to see that it knows of all the AEC's possibilities and that the Department of Defense properly uses these possibilities. Actually the MLC, because of its membership, which is primarily military, is favored more toward requirements than screening.

On the chart, and again very schematically, I have shown in red the operating agencies which, once a requirement is recognized, really accomplish the work. In part these are service laboratories, but a more important part is the services' contractors. It is they who know and work with the AEC's research laboratories.

Next, the placing of requirements and manner of coordinating research and development. With this description of legislative intent and agency organizational structure in mind, I shall pass now to the meat of our discussion. Specifically, I shall describe how a requirement for research and development in a certain field is established and how jointly carried out. In so doing, I must break my discussion into three areas, for the pattern differs somewhat as between the three. These are: the weapons area; the reactors area; the area of more basic research—that which in the AEC is accomplished by its Research Division and its Biology and Medicine Division.

In the area of nuclear bombs and warheads, you will recall that, by law, the Commission has sole responsibility for production as well as research and development.

We have in this area a formal division of responsibility of long standing and precisely spelled out.

First, we in the AEC develop and produce bombs in full. This includes the nuclear parts, the fuzing parts, the firing parts; the bomb in toto.

Second, for missiles, we develop the nuclear and firing parts, but the fuzing and the carriers are the responsibility of the Department of Defense.

A requirement starts with a service, is stated formally by the Joint Chiefs of Staff, is screened by the Secretary of Defense and sent to the AEC through the Military Liaison Committee as being a real need. Priority, or time of the requirement is stated.

Thereafter, of course, few questions are asked at the Washington level. Only questions as to whether the need still exists and whether or not we are on schedule. The appropriate nuclear laboratory (Los Alamos or Livermore), with the Sandia laboratory, establishes with

the Department of Defense agencies concerned (their laboratories and contractors) steering committees to see that the work progresses in harmony and on schedule in all its parts.

In the field of nuclear reactors, the second of the areas I mentioned, the division of responsibility also is well specified and well understood.

Here, the Commission has responsibility for developing a reactor design to a point where it is an effective article. It has responsibility for improving its design or its successors. However, once a design is satisfactory, it turns to the Department of Defense for the procurement of operational parts. The Commission also limits its work to activities connected with the reactor proper. It leaves to the services the development of the carrier or other military user.

A requirement in the reactor field starts again with the service. The Joint Chiefs of Staff, to date at least, is not an element in the Department of Defense promotion or screening. Captain Conrad is pointing to the chart as we go through to show the change.

Where substantial AEC effort is involved, a service request must be approved by the Secretary of Defense after consideration by the Assistant Secretary and the Coordinating Committee on Atomic Energy. After the Department of Defense requirement is finally stated to the AEC, the work in the reactor field (as in the weapons field) must be coordinated largely by the field agencies of the AEC and the service concerned. Yet here is a basic difference between the weapons pattern and the reactor pattern.

The Commission adopted a concept of dual status organization at the time the Division of Reactor Development was established in the beginning of 1949. This was first adopted with the Naval Reactors Branch of the Division of Reactor Development and has subsequently been applied to the Army Reactors Branch, the Aircraft Reactors Branch, and most recently to the Maritime Reactors Branch. In this concept, the Atomic Energy Commission's Division of Reactor Development Branch in question is in a dual status with its Chief and other personnel also responsible for handling research and development operations in the nuclear power field for the corresponding Department of Defense or Department of Commerce activity.

Just to show this a little more clearly, a man such as Admiral Rickover sits in part in the Commission as the head of the Naval Reactor Branch there. He also has a function within the Department of the Navy and a hat in the Department of the Navy to enable him to carry out parallel functions in the Department of the Navy, so the two mesh.

Thus, the Chief of the Naval Reactors Branch is also the Assistant Chief of the Bureau of Ships for Nuclear Propulsion, the Chief of the Army Reactors Branch is Special Assistant for Nuclear Power to the Chief of Engineers of the Army, the Chief of the Aircraft Reactors Branch is also Assistant Deputy Chief of Staff Development for Nuclear Systems, and the Chief of the Maritime Reactors Branch is Nuclear Projects Officer reporting directly to the Maritime Administrator. The other personnel of their branches likewise are in a dual capacity.

The exact division of effort is not quite completely in accordance with the normal Department of Defense breakdown of functions in that the Aircraft Reactors Branch also handles naval aviation matters and a Deputy Branch Chief (naval officer) and his immediate

staff are also members of the Navy's Bureau of Aeronautics. Also, the Army Reactors Branch has responsibilities in the Air Force's Office of Installations and in the Navy's Bureau of Yards and Docks, and the Maritime Reactors Branch in addition to its direct connection with the Maritime Administration of the Department of Commerce also maintains close relations and shares some staff with the Coast Guard.

The Commission has found this dual-status approach is very successful. This approach has often been called the "single manager concept" or the "joint task force" approach. Although it does impose some degree of administrative difficulties, the operating effectiveness of being able to direct operations with a complete singleness of purpose more than compensates for these difficulties. Naturally, since a single operating group is operating for both the AEC and for the other department concerned, there is no competition between the Commission and that department. It should be recognized that all of the Commission's operations (and nearly all of the other agencies' operations concerned) are, in fact, carried out through contractors and that some degree of deliberate competition is introduced at times between contractors.

Normally, the development of a specific nuclear powerplant to meet a military requirement of the Department of Defense, or to meet other similar requirements of the Maritime Administration, or others, is carried out by the Commission as the result of a specific request formally made by the agency concerned. General preliminary studies and a certain amount of long-range development may be carried out by the AEC before the establishment of any specific objective. The AEC's development efforts are restricted to the reactor itself and its closely associated components. The other agency carries out parallel developments, often with the same contractors, or such associated items as aviation gas turbines, steam turbine propulsion plants, and the like, with the entire development work being directed by the same operating group as mentioned above.

In summary, in the area of the development of nuclear powerplants to meet specific end objectives, which of necessity implies continued research, development, and testing programs, the Commission has operated joint groups and believes that this is a most successful method of directing complex development programs to achieve the most rapid progress. This is a development program of the nature here involved.

Mr. McCormack. General, you said, although it does impose to some degree administrative difficulties, and so forth. What are those administrative difficulties?

Brigadier General Starbird. I would like to turn that over to Mr. Roddis.

Mr. Roddis. The administrative difficulties to which reference is made there are twofold. Consider first the difficulties of the single manager in trying to work in two frameworks. He has 2 budgets to prepare and defend through 2 different chains. He has two types of contracts to defend and execute. Sometimes the differences between them are small, but one of them represents standard practice in his Department of Defense or the Department of Commerce, and the other represents standard practice in the Atomic Energy Commission, and sometimes lawyers being what they are there is a little time spent

in trying to get complete agreement on both sides to some minor point. This type of problem is the one I have reference to on the part of the single manager operating beneath him with his contractors. These are not difficult problems and certainly the gains to be obtained are more than compensated.

There is another type of administrative difficulty concerned with the people who are over the single manager to a certain extent since this individual works for at least two people and that is he is on his own a great deal. These problems I attempt to characterize here as administrative difficulties only to point out that they were recognized when this dual status concept was established and has been maintained, and that taking them into account it is still the firm belief of all of the people that deal with this in the Commission that the balances are much more in favor of this type of organization because of the singleness of purpose involved.

Mr. McCormack. Well, the single manager concept and the joint task force approach seems to be a little bit inconsistent with one another. The single manager is where somebody has the power to make decisions and authority to carry them out. Joint means in connection with others.

Mr. Roddis. The joint task force has a task force commander in charge who is one man. The task force commander is always one individual, and ultimately this is a necessity if you are going to have decisions made. That is why the words are set up there as synonomous.

Mr. McCormack. Are there any questions at this point by any member of the committee; I mean in relation to this subject?

Mr. Poland. Your statement mentions that all the Commission's operations are carried out through contractors and some degree of deliberate competition is introduced at times between the contractors. Would you comment on that as between universities and industrial and other contractors?

Mr. Roddis. The type of contracting we are addressing ourselves to here is not research contracts in universities. It is true that, for example, the Argonne National Laboratory is operated by a university, but it is not a university type operation as such. The type of competition that I have in mind here is, for example, to take one that I am very familiar with, the General Electric Co. was working on a powerplant for the submarine *Seawolf*. Westinghouse was working on one for the submarine *Nautilus*. There was a third effort in the early days that the Allis Chalmers Co. was working on. This started out pretty much neck and neck. Historically the *Seawolf* powerplant was initiated first. I think history has shown this was worthwhile competition. The *Nautilus* was obtained, I believe, more quickly in view of the competitive nature of it and it turned out to be the more successful plant. If we had gone down the single path we would have been stuck with the *Seawolf*.

Mr. Poland. They are development contracts?

Mr. Roddis. Yes.

Mr. Poland. They are not basic research?

Mr. Roddis. Yes; they are not.

Mr. Poland. We have had testimony before the committee on the relative desirability of basic research contracts as between the university type and those like the National Laboratory at Brookhaven, for example. Would you comment on that?

Mr. RODDIS. First, I should say by the very name of our division, we are not engaged in basic research. We are engaged in reactor development, so that I believe that the people who should speak to the specific point of basic research should properly be Dr. English or Dr. Dunham, who are in that phase.

Brigadier General STARBIRD. The testimony will cover this to some extent as we go through it.

Mr. POLAND. I shall be glad to hold the question.

Mr. LANIGAN. Do you find the approach which you call a single-manager concept or joint task force concept tends to eliminate unplanned or what might be called wasteful duplication and allow you to have planned competition where you feel it is necessary? Do you think you are better off with this single-manager approach than you would be if each of the three military forces were developing its own reactors?

Mr. RODDIS. In the field of development—and I would like to make this very clear, because although I am not going to address myself to the basic research approach, I agree with what the other people will say, but in the field of development where your effort is to produce something with the minimum time lag between inception and execution, I firmly believe that the singleness of purpose that results from the single-manager concept more than compensates for the losses.

Now, it is obvious that since you do put your effort in the hands of one individual that if that individual doesn't believe in some other approach that somebody is trying to push in a different direction that other approach doesn't get very far, and in basic research that is very important, but I think when you are reaching the stage of execution, which is basically what development application engineering is, why, then the time lag is the most important problem that you are trying to get around. Now, the exact way in which you devolve this is perhaps not the most important thing. We think that this way is very successful. It can be done other ways also.

Mr. LANIGAN. Could I ask General Starbird a question? General, you are in charge of the Military Applications Branch, and in that connection you mention that the Atomic Energy Commission actually produces the atomic components; that is, the warhead and so on, but that the military agencies produce the delivering power; that is, the missiles. Is it your observation that the Atomic Energy Commission works more smoothly and with more singleness of purpose than the three military departments in getting the task accomplished?

Brigadier General STARBIRD. In my opinion, yes. I may be hanging myself when I some day go back to the Department of Defense, but I will answer you frankly, yes. The Department of Defense is a bigger organization and any bigger organization is less easy to control your activities and direct them immediately down a certain channel. The Commission is relatively small, and it has historically been able to give its contractors more freedom of action than the Department of Defense has been able to do. For that reason the Commission accomplishes, in my opinion, things faster than does the Department of Defense, and I would not be surprised if it does not accomplish them as economically or possibly more economically.

Mr. LANIGAN. The other factor I am interested in was the fact that you have three services, say, developing the missile and then the one service developing the warhead. Now you may have some

modifications of warheads for different types of missiles but still it seems to me that you would be able to coordinate your information more easily than the three military departments would be able to coordinate their information.

Brigadier General STARBIRD. Let's say that you have three different missions. We are able to say, much easier than if we were three different parts, here is something that can be used in all three. Does that get at what you are driving at, sir?

Mr. LANIGAN. Have you had specific examples where you have been able to do that?

Brigadier General STARBIRD. Yes, sir, we have. I am not able, because of classifications, to name them, but we do have them.

Mr. MCCORMACK. I take it you have thought that in the Defense Department there should be a reassessment of management—I will just confine it to the field of research and development—with greater authority and power to make decisions and authority to carry them out with singleness of purpose on the higher level.

Brigadier General STARBIRD. Sir, I am not qualified to comment on that because for 2½ years I have been with the Commission, and I made the point earlier that the Department is a much larger organization. It is terrifically larger and therefore it must have different ways of operating than we have in the Commission.

Now whether there should be further centralization of the control of research and development, I am just not qualified to answer now.

Shall I go on, sir, with the text?

Mr. MCCORMACK. I hope that that may not hang you when your present tour is over. I say that for the record because it might be helpful.

Brigadier General STARBIRD. No, sir. I was probably being overfacetious there. Excuse the remark.

Mr. MCCORMACK. Do you want to strike it out?

Brigadier General STARBIRD. No, that is all right.

Mr. MCCORMACK. I think this little colloquy might be understood and evaluated. That shows also the difficulty of trying to serve two masters; that is, putting the man in a position of serving two masters.

Brigadier General STARBIRD. I serve only one right now, sir.

Mr. MCCORMACK. But you always have in mind the fact that you are going back to the other one.

Brigadier General STARBIRD. It doesn't affect my actions, sir.

Mr. MCCORMACK. I am sure it doesn't, but still the very fact that you mention it shows that thought is in your mind.

Brigadier General STARBIRD. I appreciate the chairman's remarks.

Mr. MCCORMACK. I know I couldn't escape it.

All right, General.

Brigadier General STARBIRD. In the field of basic research to include the responsibilities carried on in the Commission's Division of Research and Division of Biology and Medicine, no formal statement exists as to what the Commission should do, when, and for what purpose. This is, of course, appropriate in any field of more basic research. The Commission's representatives know by continued direct contact with their DOD counterparts what problems exist. They know what research the Department of Defense is coordinating and carrying out. They know the importance of the facts they develop, and forward new information which the DOD can use. They block

out (but not as Secretary of Defense—Commission level) the work each should follow. Here the work is relatively free and harmonious, without pressures of immediate use which accompany the weapons and reactor applied research.

The cooperation between the various agencies of the Department of Defense and the Division of Research of the AEC may be described in three parts, as follows:

(*a*) The Division of Research and the Office of Naval Research have, from the beginning of the AEC's program in research, cooperated in a program of joint support of unclassified research in nuclear physics. This program consists of support for 46 university research projects. The financing of these projects is shared between the Office of Naval Research and the Division of Research, AEC. The total level of this program in fiscal year 1957 was approximately $6,900,000 and remains at approximately this level in fiscal year 1958. From its inception the program has been conducted on the basis of joint decision between the technical staffs of the two agencies with respect to projects which would be supported. These decisions are made after a joint technical review of the proposed programs. In previous years ONR has been the agency responsible for the adimnistration of the contracts, with approximately equal funds being provided by each agency. In the current fiscal year some of these programs will be administered directly by the AEC, while others will be administered by ONR. The reason for this agreed change in administrative procedures is because of the strong AEC interest in the field of high-energy-particle accelerators. This has resulted in an agreement that the AEC should take over and administer directly those programs in this field. This change in administration does not affect the practice of joint technical review and discussion which will continue as in the past, as well as joint financial support.

(*b*) The various agencies of the DOD also have programs for support of university research projects in other areas of the physical sciences such as physics and mathematics, chemistry, and metallurgy and materials. The DOD agencies primarily involved in this program are the Office of Naval Research, the Office of Ordnance Research of the Army, and the Office of Scientific Research of the Air Force. The AEC Division of Research through its Physics, Chemistry, and Metallurgy Branches also supports programs of university research in those fields. These programs, while closely coordinated, are independently administered and are not joint programs as described above in the case of the program in high-energy physics. Frequent contact is maintained by representatives of the AEC and the DOD agencies in each of the physical-science disciplines, in order that each of the agencies be informed of the actions, programs, and interests of the others. Detailed lists of proposals received and actions taken on each are exchanged monthly between the various agencies and this information is supplemented by frequent meetings of the technical staffs concerned in program administration.

(*c*) In connection with its research in controlled thermonuclear energy the AEC cooperates with the Naval Research Laboratory. The NRL conducts a program of research in this field and this program is supplemented by funds supplied by the AEC.

In connection with areas of research which are undertaken by the AEC's Division of Research and its counterparts in the Department of Defense, the requirements for accomplishing basic research are generated by the basic-research scientists themselves who look to the AEC and the DOD for support of their programs. We support those programs which appear to have some bearing on the AEC programs. Since basic research is always a calculated risk we have no assurance of reaping dividends from any one basic research program, but on a statistical basis we may say that we have assurance of benefiting from a group of basic-research programs.

Mr. MICHEL. May I interrupt there with a question? We heard testimony earlier from Dr. Furnas, that in private industry we would expect only 1 out of 10 items would ever get to the development stage. While in a broad sense, in the Department of Defense, 1 out of every 2 items was actually developed and so the cost was quite large. Now drawing the line, limiting it somewhat to those activities in which the Commission is concerned, what would you say that ratio was of conceived items to those that get to a development stage or that we actually develop extensively.

Brigadier General STARBIRD. Let me start first, sir, by saying that of course those we take into development stage of those of the Department of Defense—I am talking about reactors and weapons—those that we take into a development stage are those for which an express military requirement has been developed and recognized. We generally do not take anything into development unless it is so recognized that there is a requirement for it.

Now, in the field of basic research and in the field of biology and medicine, we do not have, of course, that development effort, so I think we go back to the two fields that Mr. Roddis had and that I had, and here it is almost impossible for me to give a percentage. I would say the percentage is extremely high. It is high for this reason: We watch and see whether something is developing as a requirement. We do this from the time the idea is conceived. If the conception period shows that there probably is no requirement, we put that research and development on the back burner and we bring to the fore only those that look as though they are a real requirement and we only shed them off when it appears that there isn't a requirement. Once the requirement is fixed, then they go on the front burner to cook out as rapidly as possible.

Mr. MICHEL. But is the principal determination made by the Department of Defense?

Brigadier General STARBIRD. That is correct, sir, both in my field and in Mr. Roddis' field.

Mr. RODDIS. With the exception, I should say, I have eliminated throughout reference to the civilian power program of our Division because it is not directly related to the problem you are examining here, and naturally we do not have a stated military requirement in that field. As you are aware, it is a subject of rather extensive debate between the Congress and the Commission in that specific field.

Mr. POLAND. Is that a development program or production program?

Mr. RODDIS. Development program.

Mr. POLAND. Shippingport is a development project, or would it be production?

Mr. RODDIS. Shippingport is a development unit, the only production which the Division of Reactor Development is involved in is that we do manufacture for the Navy the actual nuclear components of all of the nuclear ships and we would rather expect to get similarly in the business when other activities enter the development stage in it. In the reactor business at the present moment I would say that the Navy is the only one that is in the production end and we actually make the nuclear components. They are funded by the Navy. The funds are transferred to us and we actually make the procurement and deliver the completed article.

Mr. POLAND. How would you differentiate between—perhaps I am thinking of end results—differentiate between development and production? I though Shippingport was putting power on the line.

Mr. RODDIS. It is producing power. To that extent it is a production unit. I think you must define production a little differently in each case. I would say the production for civilian power would be to produce power which is economically competitive with conventional fuel sources, and, to the best of my knowledge, none of the reactors being built anywhere in the world today will do that when they start up operation. They may at some later period.

Mr. BROWN. The hope that develops is that that will come about.

Mr. RODDIS. The whole purpose of doing this is ultimately it will be.

I might point out the first electric station started up at Pearl Street in 1886; at that time electricity cost a great deal more. It cost more to light your home with electricity than gaslight did. That was a development station and I presume in the context you mean it was for the production of electricity. As such, Shippingport is a production unit.

Mr. MCCORMACK. Has there been a slowdown in that particular program due to the increased costs?

Mr. RODDIS. You mean in the civilian power program as a whole?

Mr. MCCORMACK. Yes.

Mr. RODDIS. That is a very difficult question to answer, sir.

Mr. MCCORMACK. Is it difficult—well, all right.

Mr. RODDIS. First, I don't think there has been a slowdown. I should state that the United States, with reserve extending at least 100 and perhaps 500 years into the future of conventional fossil fuels, has probably the least immediate need for power from nuclear sources, economically competitive power, of any country in the world, so that straight economic incentive was low to begin with. It was recognized to be low. So our efforts are reasonably long range.

There are under active construction in the country today, in addition to Shippingport, five large nuclear powerplants. I think that this is an adequate number to carry the development forward at the present time. Now in the near future there should be more started and this is what the principal subject of debate between the Commission and the Congress is, as to the mechanics of doing this. I don't think there is any disagreement as to the end objective, but there is considerable disagreement as to the mechanics of doing it and I am just not qualified to comment on that in detail.

Mr. MCCORMACK. Well, I don't think we will ask you for your opinion because we appreciate your position here, the delicacy of your position. So I won't proceed further.

Mr. RODDIS. All right, sir.

Brigadier General STARBIRD. Going lastly to the field of biology and medicine, there are many areas where AEC interests in the field of biology and medicine are common and joint with those of the Department of Defense. Examples of these include such activities as transportation of atomic weapons, the fallout problem, stratospheric monitoring, bomb tests, et cetera. Many of these entail a very closely integrated joint effort, such as in the weapons-testing program, where, working very closely with AFSWP, the planning and execution of the tests involves a high level of cooperation and coordination. Similarly, in our stratospheric monitoring program, both Department of Defense and the Division of Biology and Medicine have a common interest—that of determining the extent and nature of the radio active effects of bomb bursts and weapons tests. The Department of Defense has a high-altitude-sampling program using aircraft, and you probably have read references to the many aircraft that are usually of the bomber type that are operating around our test sites during the period of test, and this effort is coordinated with the AEC's monitoring program, which utilizes balloons. The resulting information is pooled for use by both agencies, and for the development by both agencies to get the answers that we are after.

Members of the Division of Biology and Medicine participate frequently in conferences with Department of Defense personnel, and are members of several joint committees and boards. One such example is the Joint Board on Storage of Atomic Weapons. Both agencies are also collaborating in the establishment of safety criteria.

And here I apologize, Mr. Chairman. In the effort to tell the whole story we put in one little classified item which I cut out. It is obvious, I think, to the committee that with respect to such activities as conducting nuclear tests that the Deparment of Defense and ourselves must work together to develop the criteria that would be followed. In the developing of a reactor and use of a reactor in, say, a submarine, the Commission, with its experts, must advise the Department of Defense on the safety procedures to be followed.

In the field of scientific research, the research efforts of the Division of Biology and Medicine are very closely looked at in terms of efforts proceeding concurrently under the auspices of the Department of Defense and its subordinate agencies. Although both agencies have mutual interests in many fields of biological research, overlapping or duplication is effectively prevented or reduced by our utilization of the Biological Sciences Information Exchange. By means of their records, we are kept advised of research projects being undertaken by all agencies with pertinent programs. Many research projects are jointly sponsored, and, of course, the Division of Biology and Medicine has contracted with several Department of Defense activities for the conduct of basic-research projects. There is direct liaison between the Director Division of Biology and Medicine, and the Surgeon, AFSWP, on technical matters, and close working relationships exist as well with the Naval Medical Center, the Naval Radiological Defense Laboratory, and with the Walter Reed Army Medical Center, as examples.

In summary, if may be stated that in the field of biology and medicine where both the AEC and the Department of Defense recognize the need, and where common interests exist, coordination of our requirements with those of the DOD is accomplished by all techniques

necessary. These techniques include both formal and informal arrangements, and involve the highest levels of efforts and contacts.

In essence, we have, as between the AEC and the Department of Defense, certain research and development efforts that cannot be accomplished entirely within one agency alone.

Very workable arrangements have been provided by law, or have grown up through practice, which set forth the division of responsibility between agencies. Arrangements might have been developed other than the ones which exist. Yet, I can think of none which would be materially more effective and get the same amount of accomplishment with less effort.

Our working relationships at the field level have been harmonious and complementary. At the Washington level they are certainly complementary and harmonious.

That is all I have in the prepared statement, sir. We will try to answer any questions.

Mr. McCORMACK. Any questions, Mrs. Granahan?

Mrs. GRANAHAN. No.

Mr. McCORMACK. Mr. Brown?

Mr. BROWN. I have no questions. I simply want to say, Mr. Chairman, to the General, that his statement—and I did catch up with it after I came in—does give me the best picture I have ever had of the organizational structure of the Atomic Energy Commission and related agencies thereto. It has been a considerable help to this committee in studying this entire problem. Thank you very much, General.

Brigadier General STARBIRD. Thank you, sir.

Mr. McCORMACK. Mr. Meader? Wait a minute. Are you next?

Mr. MEADER. I am kind of an interloper here. I should come at the end.

Mr. McCORMACK. Mrs. Harden?

Mrs. HARDEN. Yes, I do have a question.

General Starbird, I do wish to commend you for your very fine statement. I think it has been very interesting and very informative.

You indicated awhile ago your knowledge of the closing of the atomic energy plant at Dana, Ind., which is in my district. I am wondering if you have included in your future plans the reactivating of that plant. As you know, the Government has quite an investment there.

Brigadier General STARBIRD. As far as I know, Mrs. Harden, there is no direct plan now, but we keep the plant always in mind whenever we have a new activity that is growing up or a change of activity.

The plant itself was never in the program of my Division. It was in the Production Division program. However, I can tell you that within the last 6 months, in connection with something that was an activity we needed, we made a very detailed examination of the Dana plant. We found that it wouldn't quite fit the bill. In fact it wouldn't fit the bill because this was a very specialized thing, but I do know that whenever somebody has a new requirement, he looks at the Dana plant, as well as other plants that have been closed.

Mrs. HARDEN. Thank you. It is my hope that they will be able to reactivate it because that is always a great surplus of unemployment and we need it very badly.

Brigadier General STARBIRD. It is a very fine plant.

Mrs. HARDEN. Thank you.

Mr. MCCORMACK. Do you want to follow that further?

Mrs. HARDEN. That is all.

Mr. MCCORMACK. Mr. Michel?

Mr. MICHEL. No questions.

Mr. MCCORMACK. Mr. Meader?

Mr. MEADER. Mr. Chairman, I do have a question.

General, I was very much interested in this joint operation and single manager arrangement and also the related question of overlapping between research conducted by the Atomic Energy Commission and other agencies, such as, for example, the Public Institutes of Health and the Division of Biology and Medicine or the National Advisory Committee on Aeronautics, the National Science Foundation. The question that comes to my mind as you were reading your statement was the extent to which Congress maintained its control over the appropriation of public funds for research purposes. It would be conceivable that somebody would have a pet project and if he didn't find the money in the AEC, maybe he would find it in the National Advisory Committee on Aeronautics or in the Department of Defense and our appropriation subcommittees are set up so that they look over the budget of a particular agency. Is it conceivable that the Congress might lose control over the expenditure of public funds on research activities by this overlapping and the possibility of taking funds from one department's appropriation, rather than another, to carry on a project which perhaps had been disapproved by the appropriations subcommittee?

Brigadier General STARBIRD. I think not, sir. I will answer in part and for the two agencies which have their responsibilities definitely spelled out in law, which are the weapons field and the reactor field. We are really in the developmental field and here the law is clear as to who should do what.

Now in the more basic research field, I can only say that I have listened to Dr. Dunham and to Dr. English superiors being questioned by the Appropriations Committee very actively on the point of well, now, is this duplicating anything else, what have you done to eliminate duplication as between you and other agencies. I think basically I better ask them to speak specifically now to your question, sir.

Mr. MEADER. Well, with respect to the Department of Defense—that is the type of thing that I am concerned about. I mean there is the Military Appropriations Subcommittee and suppose part of the Department of Defense budget involved a project and that committee, in its wisdom or lack of it, said "we don't believe you ought to spend any money on that." Could they come around and get money for that project which had been specifically disapproved by the Appropriations Committee from the Atomic Energy Commission budget?

Brigadier General STARBIRD. They couldn't in the field of weapons because with respect to weapons the law says that only we do it. They couldn't in the field of reactor development because here again the law is clear and says that Mr. Roddis' division must do it. In the field of basic research though, it is a possibility if the appropriations are not watched and if, basically, the agencies themselves don't coordinate,

and this was the reason I wanted to throw in to the divisions concerned, sir.

Dr. DUNHAM. As far as the Division of Biology and Medicine is concerned, we have two mechanisms by which we attempt to see that this sort of thing doesn't happen. One is before our budget review by the Bureau of the Budget I and the AFSWP Surgeon, who has cognizance over money spent in the biological and medical activity in the DOD concerned with atomic weapons and their effect, usually have a little get-together and we pretty well spell out who is going to support what and who isn't and we are held to this by the Bureau.

Mr. MCCORMACK. Which bureau?

Dr. DUNHAM. The Bureau of the Budget, before we even go to the Congress for any money at all.

Mr. MCCORMACK. They have an effect on policy, too, through those decisions.

Dr. DUNHAM. That is right.

Mr. MCCORMACK. They have quite an opportunity, through withholding of appropriation funds, to determine policy; is that correct?

Dr. DUNHAM. I think it happens.

Mr. MCCORMACK. It has the effect of that anyway.

Dr. DUNHAM. Yes.

Mr. MCCORMACK. Go ahead.

Dr. DUNHAM. As far as the Department of HEW and Public Health Service, we have a more nebulous situation. They are both supporting, for instance, work in cancer research. We have, by agreement with the former Surgeon General, Dr. Scheele, agreed that any cancer research that we support will be done at our own laboratories. There will not be grants made outside except for unique and unusual applications of AEC or Atomic Energy developments or facilities. Our cancer research program, therefore, runs to about $3½ million, of which only $200,000 is spent outside of AEC laboratories.

As far as the rest of the program on radiation effects, I have been happy to serve as a member of the Radiation Study Division since its inception at the National Institutes of Health, and in this capacity I perform a very important liaison function to see that this sort of thing doesn't happen, and through the biological sciences information exchange, which General Starbird mentioned, we have and the National Institutes of Health have cognizance up to date within a matter of 2 or 3 weeks of every proposal received by any Government agency and by the Cancer Society and the Heart Society and the status of that. So that I think, except where there is duplicated effort in the sense that two very competent people can make a contribution by slightly different approaches to a same problem, that sort of thing you have been talking about, which is wasted effort, just doesn't occur.

Mr. MEADER. I was thinking more about the transferability from one appropriation to another, where, let's say, someone had a pet project and he tried to get it through one appropriations committee and it was expressly denied there, so they go over to another agency's appropriation and finance that project from its appropriation. Has that ever occurred, to your knowledge?

Dr. DUNHAM. It has not occurred in our area, sir—very definitely.

Dr. ENGLISH. I should like to add from the point of view of the basic physical research program of AEC that insofar as the university reaserch support program goes, of which we have some 350 contracts,

these are all small sized, if you will. For example, in the field of chemistry, the average size contract is about $30,000. So that I think the appropriations committees do not in detail get each project, if you will. They certainly have access to and have information on the total number of contracts we have, where they are and the sizes of them. As a matter of fact, these are matters of public record anyway because they are printed in the AEC semiannual report which comes out once every 6 months.

With respect to the possibility of someone submitting, let's say, a proposal to the National Science Foundation, having it rejected and then resubmitting it to the AEC, it is always possible for them to submit even simultaneously to the two agencies, but, as General Starbird indicated in his testimony, we have monthly exchanges with the NSF of all proposals received, all actions taken by them and we are conferring with them almost daily. We have access to their reviewer's comments on each proposal. So we know in detail why they reject a given proposal, if it was for reasons of quality, if you will, or if it was because they felt it was in an area which was more of interest to the AEC. So there never has been this situation, the number of occasions on which this could happen I think are a real minimum, and so far as we are concerned it has created no problem.

Mr. McCormack. Any further questions?

Mr. Meader. No, sir.

Mr. McCormack. Mr. Poland?

Mr. Poland. Are you gentlemen familiar with H. R. 10293, which is Mr. Dawson's bill to establish a national science research fund? I will say briefly what it calls for. It is for the establishment of a fund of $200 million to be replenished through annual appropriations to be expended for basic and applied research upon the vote of the National Science Board when the committee of that Board shall find that the initiation or continuation of the project is of sufficient importance and urgency to justify an immediate expenditure without carrying out the usual budgetary appropriation procedures.

Would you care to comment on what you think the effectiveness of that kind of appropriation would be?

Dr. Dunham. This is the first time I have seen this; Dr. English, do you have any comment on it? It certainly would provide some flexibility for the Science Board, which might be quite useful under certain circumstances.

Dr. English. I agree I think it would have certain virtues in the sense of providing an immediate source of funds, rather than the rather long budgetary process which must be gone through. Without having thought about it in more detail, I shouldn't like to comment much more than that.

Mr. Poland. The condition precedent is an overwhelming sense of importance and urgency, which seems intended as a safeguard.

General Starbird, do you have a comment?

Brigadier General Starbird. I have not studied it either, and I did not know of it, I regret to say. I do see where it would give a great deal of flexibility as contrasted with the Board's necessity now to go through procedures whereby they get appropriations. I don't know and can't speak anything about the quantity, the sum of money in-

volved. As I remember that is several times the current annual budget of the National Science Foundation; is that correct?

Mr. POLAND. That is right.

Mr. MCCORMACK. One of the benefits that flow from making a contract is flexibility, isn't it, on the part of the contractor?

Brigadier General STARBIRD. Well, that is certainly true, sir, and it is certainly true that when a contractor feels that he is not bound by funds, he is a happier contractor than if he has to worry about adjusting his budget rigidly to a particular amount of money and still try to get a certain amount of work. We have been, I think, quite well treated by the Congress up to the present time in being allowed the funds that we need for research. This is certainly true in the field that I have in the military applications field.

Mr. MCCORMACK. I have not heard much criticism about it, General. Usually we get the criticism; don't you see?

Brigadier General STARBIRD. I know you do, sir.

Mr. MCCORMACK. I think as far back as 4 years ago the Riehlman committee looked into that also. That was one of the important points stressed—not confined to that, but enabling flexibility without the necessity of going through the rigid necessity that applies to governmental agencies. I just wanted to get your opinion or the opinion of the gentlemen associated with the Atomic Energy Commission. Does any one of you gentlemen care to comment on that subject in general?

Dr. DUNHAM. I don't think I have anything to add to what the general has said.

Mr. MCCORMACK. Any questions, Mr. Lanigan?

Mr. LANIGAN. Yes, sir, I have a few.

First of all, I wonder if you could tell us briefly what budget procedures are used in the Military Application Division and the Reactors Division and how the budget procedures are coordinated with the budget procedures of the Department of Defense, if they are.

Brigadier General STARBIRD. I will cover for military application. It is a little different, of course, with respect to reactors. Twice each year we tell the Department of Defense formally what we can do and this is in great detail. This is merely a substantiation of what we are telling them day by day verbally.

Twice each year the Department of Defense comes back to us and says these are the things which we think are needed and this is when we believe that they will be needed. We then go to our laboratories and our producers, through two operations offices. We have two field operations offices. They cost out the research, cost out the supplemental activity to the research, cost out the production. The figures come back and we consolidate them. I, personally, look them over with my staff to see that there is nothing in there that isn't needed. We then forward that as a part of the Commission budget requirement to the Bureau of the Budget, which, in turn, is consolidated into the President's budget message, comes before the Congress, and then I come to the appropriate appropriations subcommittee and testify in support of that requirement.

Mr. LANIGAN. Then the budget is determined by the information given you as to what the Department of Defense wants and it is not passed upon by the Commission as such?

Brigadier General STARBIRD. No. It is passed upon, sir, and I should say that we always are carrying on certain advance research, even in the military application field, which is not a specific stated requirement from the Department of Defense. It is only thus that you stay out ahead. But the Commission definitely reviews my budget and I defend the budget before the Commission, just as I defend it before the Congress.

Mr. LANIGAN. Does the Commission eliminate any military projects or is it just a matter of how much it would cost?

Brigadier General STARBIRD. In my field, since I have been there, I can't remember a single project being eliminated, once I decided that I would submit it to the Commission. I thought for a minute there may have been one, but I don't know of any in my field.

Mr. LANIGAN. In some cases you originate requirements on your own, rather than wait for the military to originate them, where there is sort of an advanced weapons concept; is that correct?

Brigadier General STARBIRD. This is correct, or if I think that something is coming and there hasn't been the time to formalize it through and make it into a requirement, then I can, on my own, establish that as a requirement and go ahead with the budgeting for it.

Mr. LANIGAN. And you do that to some extent?

Brigadier General STARBIRD. I do, sir.

Mr. LANIGAN. I was just wondering if Mr. Roddis could tell us how the Reactors Division is handled.

Mr. RODDIS. As I indicated, with the joint manager concept there are some difficulties in this area because—I use the term "joint manager"—we have to work in two budgetary frameworks; that is, of the Department of Defense or Departmentof Commerce and of the Commission. I don't know whether you gentlemen are aware or not, but the Commission, as a whole, is, I guess—it is certainly the only major agency and it may be the only agency in the Government that is on a cost budget basis, so that our entire operating budget is presented on a basis of cost for the subsequent year, rather than on the obligation expenditure basis that the Department of Defense and I guess all other agencies are on, and also that our construction work is on.

Mr. MCCORMACK. I think the Army Engineers are too, aren't they?

Mr. RODDIS. In some segments of their work they may be, yes.

Mr. MCCORMACK. It is interesting. You say the AEC is on that?

Mr. RODDIS. The AEC's entire operating budget is on a cost budget basis and was put in there in 1949, I believe it was. It has a great many merits in finding out on a much more current basis what your actual expenditures are. It also has some difficulties on the other end in that you are very close to your expenditures and when we don't get money from the Congress and the Bureau until into the fall, why we are sometimes near bankruptcy on a specific project.

Mr. MCCORMACK. In other words, you don't have much pipeline money?

Mr. RODDIS. That is the point, sir. The obligation budget that the Department of Defense, for example, works on represents something like a year's pipeline. We have a 3 months' pipeline involved in what is called prefinancing.

Mr. MICHEL. Would you say that the merits outweigh the demerits?

Mr. RODDIS. Of course, I am not in the fiscal business, as such. As an operator, I would say "Yes." I believe that we have, in fact, much

closer control of our contractor's expenditures than the normal Department of Defense contractor.

I operated in one of these dual-status organizations for 8 years. I might add that all of our dual-status organizations operate their Department of Defense contracts on that same basis, as far as the contractor himself is concerned, although mechanically they can't put them that way for cost-reporting purposes.

Mr. McCormack. In other words, you operate from year to year?

Mr. Roddis. That is right.

Mr. McCormack. Pretty strictly?

Mr. Roddis. That is right.

Now, from a budget standpoint, the mechanism followed in both the——

Mr. McCormack. Pardon me. That was 1947 or 1948?

Mr. Roddis. I believe it was 1949. I can supply that specifically for the record. I am just trying to draw on my memory.

Mr. McCormack. In other words, the power does exist under the law to have it done if they desire to exercise it?

Mr. Roddis. To the best of my knowledge, there was no special legislation.

Mr. Michel. This is very interesting.

Mr. McCormack. In view of what is going to happen. There is a bill coming up in the House soon, and I am going to view it with a great deal of interest and debate, and it came out of this committee. So as to bring to your conscious mind the real significance of the committee, I refer to the bill. You are jointly getting committed to the bill one way or the other.

Mr. Roddis. I should like to say that I do not represent the fiscal policy people in the Commission; but from an operating standpoint, trying to manage a program, I believe there is only one major difficulty in the cost budget; and that, frankly, is the fact that, in the 10 years that I can remember, never has the money been in the hands of the actual contracting officer before the 1st of September, and it frequently is the 1st of November. With the fiscal year beginning on the 1st of July, this always leaves you in the difficult period through the fall. Other than that, I think the cost budget operates very satisfactorily.

Mr. Lanigan. That would be due to delays in allocating?

Mr. Roddis. Frequently the appropriations bills are not passed by the Congress until into August; and the allocations, by law, I believe are allowed 60 days. I think the Bureau has 60 days' total to make allocations after the bill is written into law.

Last year, for example, I believe our appropriations bill was written into law some time around the 2d or 3d of August.

Mr. McCormack. Any further questions?

Mr. Michel. Just as a followup to several of Mr. Lanigan's earlier questions, when we touched on the subject of each of the individual services going their separate way in the development of missiles, I would assume that regardless of the size and the carrying capability that the warhead itself is interchangeable. Would that decision be made by AEC or would that be made by the Defense Department?

Brigadier General Starbird. It would be recommended by the AEC to the Military Liaison Committee, this middle body, who, in turn, would discuss it with the Department of Defense and it would be at

the Secretary of Defense level where you would have an evaluation and an interest in keeping numbers down; and then it would be either agreed that it could be done or for some reason it couldn't be done. But it would not be a direct action; it would be an agreed direction between the Commission and the Department of Defense.

Mr. McCormack. Any further questions?

Mr. Lanigan. I have just one more. You indicated that the Reactor Branch has this dual-status organization, whereas the Military Applications Branch doesn't, apparently. Have you found that there are any advantages or disadvantages as between the operations of the two branches due to one operating on a dual status and one not?

Brigadier General Starbird. I would like to say that I think, from the point of view of our responsibilities, dual managership could not work for the reason that with us not only the research and development, but the production rests within the Commission. We, therefore, don't have to go into the Department of Defense to see that something will be produced right on that end and we also have a clearer line of division as between what we do and what the Department of Defense does. For the responsibility as given to the Commission by the Congress in the weapons field, I believe the current organization is best.

Mr. Lanigan. Has the Commission made any dead-time studies of the two branches or of their operations?

Mr. Roddis. Could I first correct your statement to the extent of our Reactor Development Division is not a dual-status organization. I am not in a dual-status capacity, but of our 6 branches, 4 of them are in a dual-status capacity.

Mr. Lanigan. Three of them have concern with the military?

Mr. Roddis. Three with the military, one with the Department of Commerce. I just make that point because it is not the reactor development activity as a whole, but it is four-sixths of our activity and almost exactly two-thirds of our dollar activeness in capacity.

Brigadier General Starbird. To answer your question, I don't know of any specific dead-time studies. We have thought and considered without our agency, the Division of Military Application, of this other arrangement, but actually we have concluded that considering our responsibilities the current organization with the Commission and within the Department is correct.

Mr. McCormack. Any further questions?

Mr. Meader. Mr. Chairman, might I ask one?

Mr. McCormack. Surely, Mr. Meader.

Mr. Meader. It is possible you can answer this question, General, or maybe Dr. Dunham can answer it. What proportion of your contracted research projects are allocated to the administrative or overhead costs of the project? How much actually goes into the research as distinguished from paperwork, and so on? Do you have a top limit such as 10 percent or 15 percent of your contracts with universities or institutions that they can divert, let me say, to running their institutions, rather than to be expended on salaries and equipment necessary to do the actual research?

Dr. Dunham. It depends upon the type of work being undertaken. If we go to a university and say we would like to establish, say, a long-term study of a fairly straightforward nature, say, of the toxicity of radioaction in dogs, we would normally say we will put up the

funds to provide a facility to house the animals. We pay all costs, including overhead. On the other hand, if it is a more basic type of thing, where there is a university scientist who has a new thought on the effect of radiation on some enzyme system or something like that, we have what we call a cost-sharing type of contract in which the university comes to us with a total budget for that man's work. It may include funds from the university's endowment. It may include some support from the National Institutes of Health. Anyway, they add the whole thing up and say "This is what we want to do; we have this much money; we are asking the AEC to contribute, say, $10,000, so as to enable this work to go ahead more rapidly and we contribute that much." The total cost budget that they submit usually includes an overhead figure which the university has developed according to its practices.

Mr. MEADER. Is there any uniformity in the amount that is allowed for administration costs in your contract?

Dr. DUNHAM. We have no rule of thumb except that the Government auditors do audit from time to time the practices of the various universities with respect to their computation of overhead. This has gone on for many years.

Dr. ENGLISH. I could add from the point of view of the Division of Research, we accept, usually, the Department of Defense audited overhead rate at each university. It has generally been fixed for each university and the AEC, rather than making an independent overhead audit, accepts the Department of Defense rate. This will vary with the universities, but it is in the neighborhood of 50 percent of salaries.

Mr. MCCORMACK. Any questions?

The members of the subcommittee have confined themselves, as you will note, in asking questions pretty much to the jurisdiction of the House Committee on Government Operations. There are many other fields I know I would like to ask questions about, but it comes within the jurisdiction of other committees, such as what information you have about the progress of intermediate ballistic missiles, intercontinental, how far the Soviet Union has advanced, how far our Government has advanced. Questions like that we have not asked, as you gentlemen have noted, because we are up here on one important aspect which comes under the jurisdiction of the Committee on Government Operations.

We thank you, General Starbird, and through you the other distinguished gentlemen who accompanied you here today, for appearing before the subcommittee.

I might say the subcommittee will meet tomorrow at 10 o'clock and General Gavin will be the witness.

Mr. LANIGAN. Could I ask one thing? Could we put in the record at this point the material we have covering the Canadian Defense Research setup, which is somewhat parallel to the AEC setup?

Mr. MCCORMACK. Is that a staff study?

Mr. LANIGAN. It is material which has been presented to us by the Canadian Joint Mission. We can only put it in in documentary form.

Mr. MCCORMACK. With that identification, without objection it will be included.

(The document reads as follows:)

The Defence Research Board of Canada

The Canadian Defence Research Board (DRB) was established by Parliament in 1947 in line with a recommendation originating within the Canadian General Staff for a permanent defence science organization. Our experience in World War II had demonstrated that this was essential if we were to avoid wasting time, energy, and money in mobilizing our scientific resources in any future emergency.

The farsighted plan recommended by the General Staff and adopted by Parliament makes the head of DRB (chairman, DRB) responsible directly to the Minister of National Defence. Further, in recognition of the vital impact of science upon modern strategy, the chairman, DRB, was made a member of the Canadian Chiefs of Staff Committee.

Because of recognized fundamental professional differences, especially in management, between scientist and soldier, it was decided that this new defence science organization should be separate from the armed services but should maintain a close relationship with them in order to retain a proper defence motivation. DRB is therefore civilian-directed and its defence research work is not carried out within the organizational framework of the Armed Forces. It is, however, a partner of the armed services and an integral element of the Department of National Defence.

The responsibilities of DRB are designated in the Defence Act, which defines statutory terms of reference of the armed services and the DRB. The Defense Research Board is required "to carry out such duties in connection with research relating to the defence of Canada and the development of or improvements in materiel as the Minister of National Defence may assign to it. It shall advise the Minister on all matters relating to scientific, technical, and other research and development that in its opinion may affect national defence."

In fulfilling its responsibilities the Defence Research Board establishes general policies for defence research and development in Canada. It supervises the allocation of the internal resources and facilities of the Department of National Defence, industry, university, or other Government departments on defence research projects, and it directs the operation of the Board's own laboratories and establishments which themselves undertake research and development on defence projects.

The Board maintains the closest possible collaboration with the United States and the United Kingdom on matters bearing on defence research and development. This is accomplished through the Canadian Joint Staffs which have been established by the Department of National Defence to represent it in Washington and London, England. The organization of the Canadian Joint Staff includes, in addition to the chairman, a Navy member, Army member, Air member and Defence Research member.

The Defense Research member, Washington, is accredited to all three United States armed services and he and his staff are responsible for liaison with the United States services and other appropriate United States agencies on all matters concerned with defence research and development.

Below is a list of the Defence Research Board's establishments and laboratories in Canada:

Naval Research Establishment (NRE), Dartmouth, Nova Scotia.
Canadian Armament Research and Development Establishment (CARDE), Valcartier, Quebec.
Defence Research Chemical Laboratories (DRCL), Shirley Bay, Ottawa, Ontario.
Defence Research Telecommunications Establishment, Electronics Laboratory (DRTE(EL)), Ottawa, Ontario.
Defence Research Telecommuncations Establishment, Radio Physics Laboratory (DRET(RPL)), Ottawa, Ontario.
Operational Research Group, Defence Research Board Headquarters, Ottawa, Ontario.
Defence Research Kingston Laboratory (DRKL), (BW Defence), Kingston, Ontario.
Defence Research Medical Laboratories, (DRML), Toronto, Ontario.
Suffield Experimental Station (SES), Ralson, Alberta.
Defence Research Northern Laboratories, Fort Churchill, Manitoba.
Pacific Naval Laboratory, Esquimalt, British Columbia.

November 22, 1957.

DEFENCE RESEARCH BOARD POLICY MANUAL

1.0 DEFENCE RESEARCH BOARD

1.1 *Organizing Authority for the Defence Research Board*

The Defence Research Board was authorized under Part III, Sections 53 to 55 inclusive of the National Defence Act, Chapter 184 of the Revised Statutes of Canada, 1952 which is reproduced hereunder.

NATIONAL DEFENCE ACT

PART III

THE DEFENCE RESEARCH BOARD

53. (1) There shall be a Defence Research Board which shall carry out such duties in connection with research relating to the defence of Canada and development of or improvements in material as the Minister may assign to it, and shall advise the Minister on all matters relating to scientific, technical, and other research and development that in its opinion may affect national defence.

Constitution.

(2) The Defence Research Board shall consist of a Chairman and a Vice-Chairman, appointed by the Governor in Council, the persons who from time to time hold the offices of Chief of the Naval Staff, Chief of the General Staff, Chief of the Air Staff, President of the Honorary Advisory Council for Scientific and Industrial Research, and Deputy Minister of National Defence, and such additional members, representative of universities, industry, and other research interests as the Governor in Council appoints.

(3) The Chairman and Vice-Chairman shall hold office during pleasure, and shall be paid such salaries as the Governor in Council determines.

(4) The members of the Defence Research Board, other than the Chairman, Vice-Chairman or the *ex officio* members, shall hold office for a period not exceeding three years but shall be eligible for reappointment, and shall be paid such remuneration, if any, as the Governor in Council determines.

(5) Each member shall be paid his travelling and other expenses incurred in connection with the work of the Defence Research Board.

(6) The Chairman is the chief executive officer of the Defence Research Board and under the direction of the Minister and in accordance with policies approved by the Board, shall oversee and direct the officers, clerks and employees of the Board, have general control of the business of the Board, have supervision over the work directed to be carried out by the Board, be charged with the organization, administration and operation of the defence establishments of the Board and perform such other duties as the Minister may assign to him.

(7) The Vice-Chairman shall perform such duties as may be assigned to him under the by-laws made by the Defence Research Board.

(8) The Chairman has a status equivalent to that of a chief of staff of a Service of the Canadian Forces.

54. The Defence Research Board may, with the approval of the Minister,

(a) notwithstanding the Civil Service Act or any other section of this Act or any other statute or law, appoint and employ the professional, scientific, technical, clerical and other employees required to carry out efficiently the duties of the Board, prescribe their duties and, subject to approval of the Governor in Council, prescribe their terms of appointment and service and fix their remuneration;

(b) make by-laws or rules for the regulation of its proceedings and for the performance of its functions;

(c) enter into contracts in the name of Her Majesty for research and investigations with respect only to matters relating to defence; and

(d) make grants in aid of research and investigations with respect only to matters relating to defence and establish scholarships for the education or training of persons to qualify them to engage in such research and investigations.

55. (1) All expenses of the Defence Research Board shall be paid out of moneys appropriated by Parliament for the purpose or received by the Board through the conduct of its operations, bequests, donations, or otherwise and shall be paid by the Minisited of Finance on the requisition of the Minister.

(2) The Minister may request the Minister of Finance to allocate any portion of the moneys appropriated by Parliament for the purposes of the Defence

Research Board for scholarships or grants in aid of research and investigations, and thereupon the Minister of Finance shall hold that portion of the moneys in trust and may at any time on the requisition of the Minister disburse that portion of the moneys for scholarships or grants in aid of research and investigations.

(3) Any moneys allocated by the Minister of Finance under this section that, in the opinion of the Minister, are not required for the purpose for which they were allocated shall cease to be held in trust.

1.2 *Aim of Defence Research and Development*

The ultimate aim of defence research and development is to enhance the effectiveness of the Canadian Armed Services. This is achieved by the application of science to the evolution of new and improved equipment and techniques.

1.3 *Role of the Defence Research Board*

The Board will therefore operate an organization designed to acquire scientific knowledge which may be applied to the research and development problems of the Armed Services and which will also contribute to the common pool of scientific knowledge available to Canada and her allies.

Mr. McCormack. The subcommittee is now in recess.

(Whereupon, at 12:03 p. m., the subcommittee adjourned.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

TUESDAY, FEBRUARY 4, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION OF THE
COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1501, New House Office Building, Hon. John W. McCormack presiding.

Present: Representatives McCormack, Granahan, Harden, Brown, Michel, and Meader.

Also present: Orville S. Poland, general counsel to the committee; James Lanigan, associate general counsel; William A. Young, staff consultant; and Elmer Henderson, subcommittee counsel.

Mr. MCCORMACK. The subcommittee will be in order.

The first witness before the subcommittee is Lt. Gen. James M. Gavin, United States Army. We are very highly honored in having you, General, and will be glad to hear from you.

STATEMENT OF LT. GEN. JAMES M. GAVIN, UNITED STATES ARMY; ACCOMPANIED BY COL. A. E. COWAN AND COL. J. R. DEAN, JR.

Lieutenant General GAVIN. It is a privilege to be here, sir, and I am delighted to appear. I have no prepared opening statement.

Mr. MCCORMACK. All the better.

Lieutenant General GAVIN. I was so uncertain about the requirements of the committee, so I prepared no statement.

Mr. MCCORMACK. That is not a strict requirement and we appreciate your position, and others that are similarly under pressure. If you want to talk from notes, why, it is perfectly all right.

All right, General.

Lieutenant General GAVIN. Well, I am at your disposal, sir, if you have any questions on the R. & D. program.

Mr. MCCORMACK. I see. You have no preliminary statement to make?

Lieutenant General GAVIN. No, sir; I do not. I didn't prepare one.

Mr. MCCORMACK. Well, there are a lot of questions we can ask you, General, because most of us in Congress don't know anything more than we read in the newspapers. That may seem strange. I am leader of the House and I don't know anything more than what I read in the newspapers as to our capabilities and their evaluation. That may surprise you, but Speaker Rayburn is the same way. I

know that from talks with him. Of course we are members of the committee and have had officers here from the armed services to testify, and they have opportunity in executive sessions and public sessions to advise us. If we ask any questions of you that are of a classified nature, why, of course, we appreciate your position.

To begin with, I notice in this morning's paper an article by Hanson W. Baldwin. Have you seen it?

Lieutenant General GAVIN. Yes, sir; I have glanced at it. I have not read it in detail.

Mr. MCCORMACK. We probably could ask questions from what we read in the newspapers.

Lieutenant General GAVIN. Yes, sir.

Mr. MCCORMACK. I don't imagine that that is particularly classified.

It says here:

> Some Americans in positions of great responsibility believe that the United States is facing the most dangerous era in its history. The next 5 years, as Lt. Gen. James M. Gavin, the Army's retiring Chief of Research and Development, puts it, may be a period of "extreme criticality."

Would you want to comment on that, General?

Lieutenant General GAVIN. Well, sir, he quoted me accurately. That is right, I do believe it is a period of extreme criticality. I base that statement on an analysis of the trend of the very dynamic technology in which we find ourselves and it gets right down to this: Both powers in which the power is polarized, the U. S. S. R. and the United States, are embarked upon missile programs. The Soviets have made evidence of considerable competence. I believe it has been publicly stated that our own program, in respects, lags theirs and we therefore are on the threshold of an era in which we may neither have a comparable capability of retaliation at the outset, let us say, although we can, by hard work, overcome this imbalance, nor would we have at the outset an adequate defense.

Under those conditions, a power such as the U. S. S. R., with a spectrum of capabilities of an impressive sort, could at least tend to exploit any advantage it may enjoy, diplomatically, militarily; ultimately, if necessary, sort of a cold-war type of action, so I think that we must work very, very hard for the next—certainly the next 5 to 10 years because we are going to be in a critical period.

I noticed that Dr. Von Braun said that if it we increased our effort 20 percent in 5 years, we might be able to catch up. I don't know that I will subscribe to those finite figures, but I know we must make a significant improvement in our effort because we are not going to see daylight between ourselves and the U. S. S. R., in my opinion, for a number of years.

Mr. MCCORMACK. Do you think that we can afford to wait 5 or 10 years?

Lieutenant General GAVIN. No, sir. There is no doubt that with the industry, and this is characteristic of the American people, imagination, inventiveness, great industry, and abundance of natural resources brought together in a good national effort, we can do well indeed, but we really must do something about it. It is no time for complacency at all.

Mr. MCCORMACK. If the Soviet Union should get a decided advantage over our country—I am not disregarding other nations of the so-

called free world, I mean outside of the Iron Curtain—where they could, with confidence, hit our targets in the United States and we were unable to hit their targets in the Soviet Union, or the possibility would be so reduced that they would take the chance, do you think that they would wait until we catch up with them? I realize you have to weigh the probabilities of the Communist mind.

Lieutenant General GAVIN. Yes, sir. This, of course, is quite a hypothetical question, and I am sure that each individual brought here would give his own answer and mine would be of this nature: If one analyzes the military philosophy of the Soviets, and I believe if one understood it, it becomes quite clear that the more likely action would be one of continued pressure around the periphery by cold-war tactics, exploiting so-called colonialism in such issues, leading people to believe that they were really trying to help them when, in fact, they were very selfish in their pattern of aggrandizement, ultimately using military power where necessary, such as occurred in Korea, and it would be a series of peripheral actions that would cause a serious erosion of the confidence of our coalition partners. This, to me, is by far the more dangerous and, if I may say so, by far the more likely successful tactics of the Soviet. This is my own personal opinion, of course, entirely.

Mr. MCCORMACK. Suppose they get a clear advantage and have us at a disadvantage, assuming a situation where they could hit our targets and we couldn't hit theirs or get to their targets, recognizing that the United States is a harbor of their opposition, might they not engage in a surprise attack?

Lieutenant General GAVIN. Well, they certainly could attempt it, but again, in my personal opinion the capabilities of any nation to reap unprecedented destruction on another is increasing and it is bad enough now, but it is increasing as we get into the missile age and a nation that would undertake such a military venture would do it with a large number of unknowns in their analysis of the international situation. We will never know as much as we would like to know about the Soviets and they will never know as much about us as they would like to know. What our retaliatory capabilities would be, I don't know for sure and the best scientific effort we make to analyze the program have given us a number of sensitive assumptions as to what we could do. I think they have the same problem and at best, therefore, it is an adventure on their part, an adventure from which they may not profit and I think, therefore, it would be unlikely that they would undertake it. So, in answer to your question, yes, they might, but I would consider that so far less likely than peripheral pressures followed by military exploitation of advantages, initially in a limited area, and these areas spreading to the ultimate destruction of the confidence of the West, I would say.

Mr. MCCORMACK. Well, it is important that we always have the ability to retaliate; is it not?

Lieutenant General GAVIN. Absolutely. This, I think, is fundamental; yes, sir.

Mr. MCCORMACK. I assume that could be eliminated. I hope the day will never arise, so we have to have powerful retaliatory forces.

Lieutenant General GAVIN. This is fundamental to our survival now days. You must have in being an up-to-date retaliatory capability.

Mr. MCCORMACK. Now you said, General, during your response

to the first question, that it can, by hard work, be overcome. Will you give your views on that? What is necessary to overcome it? In other words, we have the brains in America, haven't we?

Lieutenant General GAVIN. Yes, sir.

Mr. MCCORMACK. We have the facilities?

Lieutenant General GAVIN. Yes, sir.

Mr. MCCORMACK. What is lacking?

Lieutenant General GAVIN. Well, sir, I hope that this committee will call in witnesses in other areas because when I answer questions of this sort I get a bit out of my own particular office and organization.

I would say first of all we must cut down the time necessary to make decisions, expedite the decision-making processes. I think almost every man concerned with science and research who comes up here will tell you the same thing.

Of course, fresh in my mind is the experience of our launching Friday and this has been a very difficult problem for us to go along with because we have sought and sought a decision to allow us to go ahead and, thank goodness, we were authorized to on November 8, 1957, and we were able to launch a satellite, therefore, last Friday night. It is too bad this decision had not been made sooner.

This is characteristic of the problems with which one must deal. By the time the committees review the problems and committees on committees look at them, it is very difficult. Then, of course, not only is the problem of decision to start sometimes a difficult one to make expeditiously, but once a program in research is undertaken, the more difficult decision is that of stopping it after it is underway if it doesn't appear to show profit for the future and this, frankly, gets tied up with industrial interests and pressures of many sorts and yet we must stop the programs that aren't paying off and put our national product into those that will.

These two decisions are the things about which everything pivots—organization structures are made possible, adequate funding, and so on.

I must say I personally think more of our national product should go into research and development and more of our national product, I think personally, should go into national defense, but this gets beyond my competence because it gets into the national economy, with which I am not personally concerned.

Mr. MCCORMACK. I think as a citizen you are justified in your view. As far as I am concerned, I think the first job is to preserve our country without regard to other factors that are important, but as between the balanced budget and doing those things to assure the preservation of our country, I have stated repeatedly and I will continue to state, as long as world conditions exist, that the balanced budget is something that should be secondary in this Nation. I do not fail to recognize its importance, but as individual citizens we are entitled to our opinion. You, of course, with your years of experience, with your position, your career and knowledge, you are aware to some extent of the progress of the Soviet. You know of the progress of our country and as a citizen you would be entitled to express your opinion. It is quite important that we be powerful from a military angle, isn't it, all of the time while the world tension exists?

Lieutenant General GAVIN. It is highly important to what, sir?

Mr. MCCORMACK. That we be powerful militarily.

Lieutenant General GAVIN. Absolutely. I do not see how we can survive unless we be reasonably strong in this uneasy world.

Mr. MCCORMACK. Well, not to disagee with you, I go beyond the word "reasonably." I play it safe.

Now we will go on to some further questions. Mrs. Granahan, do you have any questions you want to ask?

Mr. GRANAHAN. Not at present.

Mr. MCCORMACK. Mrs. Harden?

Mrs. HARDEN. No questions at this time.

Mr. MCCORMACK. Mr. Michel?

Mr. MICHEL. General Gavin, you pointed out the danger of these periphery wars that we might be confronted with. Do you feel that with the launching of sputnik and our own satellite that we are inclined to put so much emphasis on satellites and missiles that we may be cutting ourselves short in doing those things that you would think, as an Army man, are necessary to handle a brush-fire incident?

General GAVIN. There is a very real danger of this sort and I might say I think it will take a lot more wisdom to decide what to do now that we have one satellite up than it took to get it up. We have to look very carefully at the situation and there is a real danger we will be so attracted by the glamor and lure of the satellite and big missiles that we will overlook the very fundamental problems.

Mr. MICHEL. As a research man, you are undoubtedly familiar with the Goer concept of transportation that we think of in terms of the future for the Army.

Lieutenant General GAVIN. Yes; I am.

Mr. MICHEL. How was such a concept devised? Did the Army think of it first, or did private industry think of it?

Lieutenant General GAVIN. No, sir. As I understand it, the Goer is the huge wheel that is exemplified by the big wheel you see in earth-moving equipment around the country here and there. American industry has come far and away, in my opinion, ahead of any other in the world in earth moving, in construction-type equipment. We have greater scrapers, haulers, and so on. You may recall, oh, 10 years ago, we used tracks a great deal, tracklaying gear, and then we used an ordinary small wheel, and now we have wheels as big as this room, really, although the Goer, incidentally, somewhat smaller, and we have developed unique earth-handling equipment. Industry has come to us with that, and suggested we take an interest in it. We have had samples of their equipment down at Fort Knox, and we have had industry come in for a big conference and bring samples of all of their equipment. It looks very good to us, and we are very much interested in it.

Mr. MICHEL. It has your approval then?

Lieutenant General GAVIN. Yes; it does. In research and development, it certainly does. Operationally, we will have to see.

Mr. MICHEL. We still have a selling job to do?

Lieutenant General GAVIN. Oh, yes.

Mr. MICHEL. The reason I ask the question is because I represent a district that makes this type of equipment. I know there are other districts around the country also concerned. It seeems to me we are always reluctant to change, and if we used a 6-by-6 truck way back

when, we still use it today when, it seems to me, we ought to be thinking in terms of larger payloads and fewer personnel.

I was interested in your comments as to whether or not you think it will get top-level approval, and whether you can actually move into that phase. Do you feel, as an Army man now in this field of research and development, that you are getting enough money to develop this scheme forward to give it an opportunity to prove itself?

Lieutenant General GAVIN. Sir, I have programs approved by the Department of Defense, and the money I am getting is adequate for those programs. I have asked for more money, and I would like to have more, but it is adequate. The money I am getting is adequate for the programs that have been approved.

Mr. MICHEL. We have heard some testimony earlier that in private industry we expect that, normally, 1 out of 10 ideas actually gets to production or to the development stage. But, in the Department of Defense, the ratio comes down to maybe 1 out of every 2 items that are conceived gets to a development stage, and this brings up a question of increased cost. My question to Dr. Furnas, I think, was something like this: Why is there this marked difference? Is it because the Department of Defense has so much money to play with that they can afford to get into development, where private industry says, from a pure dollar standpoint, "No; this isn't economically feasible; we won't go to that extent"? Do you think that is out of proportion for the military, or is that percentage correct, would you say?

Lieutenant General GAVIN. I don't know if it is correct. It is an interesting point. I would think it might be just the opposite; that we manage our programs so tightly and we are rather conservative in our money handling, so conservative, in fact, that when we really undertake a program it has a high probability, a 50-percent probability we will go into development.

I hadn't heard of those figures before.

Mr. MICHEL. They were news to me when I heard them, and they made such an impression I felt compelled to put the question to you. I will yield to another member.

Mr. MCCORMACK. Mr. Meader.

Mr. MEADER. General Gavin, based on your experience with research and development in the Army, are you satisfied that the organizational structure of agencies contributing to research and development by the use of Federal funds is adequate, and that the procedures are adequate and, if not, do you have any suggestions as to improvement in organizational structures and procedures?

I have in mind a charge that there have been delays in making decisions; that there are duplications in research programs; that there is interservice rivalry and not a free and complete exchange of information between even military departments engaged in research or financing research. I would like your comments on the adequacy of our present organizational structure and procedures and whatever you might be able to suggest as improvements.

Lieutenant General GAVIN. Well, sir, may I say that interservice rivalry is a popular whipping boy these days and, in my opinion, there is far more interservice cooperation than there is harmful rivalry, and interservice rivalry, to some extent, is good. Competition is the essence of the entire American system. It is very difficult

for a man to associate himself with a particular form of combat effort without feeling in development that he wants to help that type effort. I think the current missile program reflects, in the speed with which these missiles are coming into the inventory, Thor and Jupiter, for example, reflect the high degree of competition between the services involved.

Now, I can assure you there is a complete and full and free exchange of information. We have never fired, for example, a Jupiter missile without calling all of the people of Thor and giving them all of the information. We have given them all the information in a technical discussion. In the Navy program, as a matter of fact, I accepted a 4-month delay in Jupiter and put a million dollars in their program to help them get started on the Navy program.

No; we have a full and free exchange of information. I wouldn't be concerned about interservice aspects of the present research and development situation.

Now as for the structure, it needs looking into, and I can only talk for the Department of the Army and the Department of Defense, because that is what I am familiar with. There are other witnesses far more competent than I to talk about the national structure.

The Department of Defense structure is being looked into now. As you know, there is an Advanced Research Projects Agency under consideration. Mr. McElroy, who is an extremely able man, is making some good decisions, and he has that now under consideration, and I think out of that will probably come a lot of good. What he does underneath that, I am not sure, and all I can say is that he is looking into the organizational structure of research and development in the Department of Defense.

Within the Army itself, within the past 2 years, we have been able to get a tremendous amount done. Thanks to Dr. Hovde, who is here in the room, we have had one of the finest groups of scientists on the Army Scientific Advisory Panel who are advising us. It is broken down into seven panels looking into highly specialized areas. They meet regularly, and we have contact with them, and they have been extremely helpful to us. In the last 2 years, in the research and development program in the Army, we have brought it out of a lower echelon in logistics up to the Deputy Chief of Staff level—sort of a vice-president type of arrangement. I am now reorganizing to put greater emphasis on research itself, and Army Research Office. I am trying to get organized, and I hope I may obtain approval from our Secretary and Chief of Staff for that. But we are looking into our organizational structure ourselves. We have made a great deal of progress in the last 2 years in the Army research and development program.

Mr. MEADER. What do you have to say about existing procedures and their possible improvement? It has been said that too many people have to give approval before a final decision is made. Do you agree with that comment?

Lieutenant General GAVIN. Yes, that is true.

Mr. MICHEL. I think that was the first point the general made earlier, the cutting of time for decision making.

Lieutenant General GAVIN. I think Mr. McElroy is really doing something about this now, but we, unfortunately, have had a situa-

tion where the Assistant Secretary for Research and Engineering would consider a project, but then the Comptroller would also consider it and you had to please both independently and do a great deal of briefing and justification and justification on justification before you could get a project approval. And then this is always true in case of tight money, where they have to decide on this in your own service and this compared to that in another service, and you get down to some very fundamental problems. Ultimately this sort of thing gets into JCS because there is a question is there a requirement for this sort of thing in the roles and missions of the services, and by the time you get through the Joint Chiefs of Staff committees and Department of Defense committees, and meantime, along the way, there is a change of Assistant Secretary, the decision making gets to be rather slow. Mr. McElroy, I think, is looking into this entire situation now.

Mr. MEADER. Have you commented already—I came in late, so you may have covered this—have you commented on Dr. Furnas' suggestion that the Assistant Secretary of Defense for Research and Development should have more authority over research programs of the Defense Department and that possibly 10 percent of the funds allocated to all of the 3 services should be under his control?

Lieutenant General GAVIN. Now let me say I admire Dr. Furnas. He is one of the most able men we have had in Washington in this field and I would be inclined to go along with him in every respect on this point. He does need a fund to take advantage of—well they use the word "breakthroughs"; it is overused a bit. But things come along you hadn't anticipated when you defended your budget before the Congress.

During the year, the situation is so dynamic that many things can happen, and he should have funds he can put right into something and push it.

Now the Assistant Secretary for Research and Engineering, as it is called in the Department of Defense now, in my opinion should have authority to do something about this and not have to keep going back to the money man and saying well, let me do this and let me do that and get in a position where the money man tends to override him.

Mr. MCCORMACK. Who is the money man?

Lieutenant General GAVIN. The Assistant Secretary (Comptroller), Mr. McNeil.

Mr. MCCORMACK. And does the Bureau of the Budget come into the picture, too?

Lieutenant General GAVIN. Well, they do, but this is out of the Department of Defense.

I talked to Dr. Furnas in the last few years a number of times about projects and we would see eye to eye on them, but I couldn't get them through the money channel. I would agree entirely with what he said.

Mr. MCCORMACK. How do you think the organizational setup can be improved? Have you any suggestions to make as to that, in connection with the decision-making power and the authority to carry it out?

Lieutenant General GAVIN. Well, sir, I would hesitate to get specific about the organizational structure in the Department of Defense.

I would support fully the views of Dr. Furnas and the people who worked up in that area are much more competent to comment on that than I am. I can only tell you of my own experiences and what I think the problems are in the light of that which I have tried to do here. I have great confidence in Dr. Furnas and I would say his testimony would be pertinent and very worthwhile.

Mr. MICHEL. General, would you like to have this to exploit a breakthrough, and would you say that from a security standpoint there is possibility too much publicity attendant to your coming back here to the Congress to get additional funds?

Lieutenant General GAVIN. Well, this is certainly a possibility.

Mr. MICHEL. I was interested in your comment in reply to Mr. Meader's question about interservice rivalry. The Army, on the morning after the launching of Sputnik I, through the press, gave me the impression that they were depressed that they didn't get this assignment earlier, which was an indication to me that they could do what they did a few days ago and, as you said, maybe the scales weren't tipped in their favor, but in Navy's favor, but there couldn't have been a complete interchange of information if one had the capability and it wasn't used in the other service.

Lieutenant General GAVIN. No, sir, this isn't quite so. There was a complete and free exchange of information. The Navy didn't have a Redstone missile, nor did they have a Jupiter missile. They just didn't have the missile in their service, nor did they have the laboratories behind it, nor the technical help to handle it, nor the skills to launch it. So there was no way you could do it. The missile they used, the Viking, was used by the Navy for high-altitude research, so they were using a purely scientific missile which they had.

Mr. MICHEL. But my point is when Jupiter has proved itself as with the capability that it has, Army would be reluctant to say "Navy, here is our Redstone missile that you can use from this point on; obviously it is better than what you have at this point; now go on from this."

Lieutenant General GAVIN. Quite the contrary, sir; that is what we did. This is a Navy program still. This is our contribution to Vanguard. Right over here across the river, at the Office of Naval Research, they are handling the thing just as though it were a Vanguard that went up. We just gave them the complete missile and put all their instrumentation in our nose.

Mr. MICHEL. But they are still trying to get theirs off, as I understand.

Lieutenant General GAVIN. Yes, I understand they are.

Mr. MICHEL. It is a little bit confusing.

I will pass to the chairman.

Mr. MCCORMACK. Mrs. Granahan.

Mrs. GRANAHAN. General, in your opinion when could we have launched this missile if you had had the proper authority to go ahead? How long did we lag, if I may use that word?

Lieutenant General GAVIN. Mrs. Granahan, it is very difficult to say, but we were in some doubt ourselves until September 1956, when we successfully launched a test vehicle for the Jupiter nose cone that went very, very high—684 miles up.

Now at that time we asked permission to go ahead and stated that in 3 months—no, I beg your pardon. We stated we could launch in

June of 1957. It is like on Monday morning to call the turn of the game on Saturday, now that we have launched it, but there was always an uncertainty until we did it.

Mr. McCormack. Well, there are other types of activities besides missiles, General, aren't there? There is biological and chemical.

Lieutenant General Gavin. Yes, sir.

In response to a question raised a moment ago about the great preoccupation now with satellites and missiles, I would like to say that the technology in other fields is just as dynamic as it is in the satellite and missile field. Even ordinary things like land mobility and the Goer principle in what we call zero ground pressure vehicles, the so-called close to the ground air vehicle. The field is very dynamic in both CW and BW. It is obviously a very changing and dynamic field and the Soviets have been dynamic in their statement that they have a capability and intend to use it. We must keep our eye on this and not become too preoccupied with the satellite and overlook the fundamentals. I speak of the Army. We have an objective in life, and that is to give the American people a kind of Army that can deal with any land force at any time they are sent to do it. The CW–BW is a sizable program. We put a lot of our resources into that program. We could use more.

Mr. McCormack. I noticed that you testified before the Preparedness Subcommittee of the Senate Committee on Armed Services that, "I have watched the deterioration of our military forces with increased concern." Would you care to elaborate on that?

Lieutenant General Gavin. Well, sir, I have had two tours in Washington since the war, one in Weapons System Evaluation Group, where I had an opportunity to become intimately acquainted with technology and research and development, and with that background I returned again to the Pentagon 4 years ago. I have felt during these 4 years that the real challenge that we would have to face up to would be that of peripheral action and the real danger was in that area.

The Army has sought to address itself to that problem, but in doing so it has dealt with a continued deterioration of the strength and available dollars and it has become very, very difficult. Even when you see Explorer go by, you must realize that with every flight overhead you see that means there is considerable less in the Goer principle, there is considerable less in diesel engines for our tanks, there is less effort in the SW–CW field. To support that I have taken quite a few million dollars out of other research and development programs and put them into missiles.

Now aside from that, the fact is that our budget has steadily deteriorated for 4 years and our strength has deteriorated in the face of of a situation that, in my opinion, is calling for more and more of the kind of force that only the Army and, if I may say so, the Marine Corps can provide in number.

Of course it needs the full participation of all services in peripheral action, but applying power against the discrimination of forces on land, this is our business and without an Army capable of doing this, I don't see how we are facing anything but a very serious situation. If the Army can't do its job, we are in real deep trouble.

Mr. McCormack. How many divisions have we got now?

Lieutenant General GAVIN. We have 15 now, going down down to 14, and of course we have absorbed the training establishments. It would be difficult to put a number on equivalent combat strength divisions, but it is something on the order of 11 or so. We have the training establishments absorbed.

When I came to the Pentagon 4 years ago—I have the figures here if I might refer to them.

Mr. MICHEL. Are we talking about pentagonal or triangular divisions now?

Lieutenant General GAVIN. Pentomic. We are switching to pentomic. The gross divisional strength 4 years ago was 27 and that included quite a few training divisions. Now the gross by comparison is today 15 and it is going down to 14. Again I am not sure of the training establishments in there, but it would be the equivalent of about 3 or 4 division or so.

Mr. MCCORMACK. What divisions have NATO and our allied countries?

Lieutenant General GAVIN. Sir, I am not sure offhand what their divisional strength is now, but they are far short of the Lisbon goals.

Mr. MCCORMACK. We are aware of that.

Mr. BROWN. Mr. Chairman, what about firepower? We are told while we have a lesser number of men in the Army, we have greater firepower than ever. Is that correct or not?

Lieutenant General GAVIN. Well, sir, I don't know—this is one of the illusions of our time—that you can equate firepower with manpower, and ultimately, if you get enough nuclear weapons, you won't need any men. Honestly this won't work out. It is my personal opinion the highly complex weapons, the equipment we are getting into will require more manpower in the future if you are going to use them effectively. We do have more firepower—everybody does—unprecedented firepower.

Mr. BROWN. It is a relative thing between nations?

Lieutenant General GAVIN. Yes, it is. Our position in relation to the Soviets isn't any better because we have the firepower. In fact, missiles shown in the November 7 parade in Moscow on the anniversary of the Soviet Revolution, those missiles and equipment that went with them were tremendously impressive, and obviously very good and very fine missiles.

They have firepower in abundance, tactical nuclear firepower.

Mr. MCCORMACK. Any further questions, Mr. Brown?

Mr. BROWN. No; I think not.

Mr. MCCORMACK. Have you any information as to the strength of the Soviet Union as far as foot soldiers are concerned?

Lieutenant General GAVIN. Yes, sir. They are rated at 175 divisions. Now they have been modernizing steadily. I am not sure offhand of the proportion of the infantry and armored divisions, but it is true that the number of armored divisions has been increasing and the mechanization has been increasing at a steady rate, so that they are obviously now a rather highly mobile outfit, well equipped with modern missiles, and they are giving away good equipment. The equipment they gave the Egyptians was very good.

Mr. MCCORMACK. Along that line, aren't there in the U. S. S. R. what we might call reserves in the United States capable of being called into service?

Lieutenant General GAVIN. Yes; they could call up a great deal more and of course they have a tremendous satellite power, for example, in China.

Mr. MCCORMACK. They have compulsory military training over there?

Lieutenant General GAVIN. Yes, they have.

Mr. MCCORMACK. So they have a tremendous reserve they can immediately employ and you understand they are pretty highly trained, too?

Lieutenant General GAVIN. Yes, sir. I have seen a great deal of them—well, I think that is a correct statement—after the war, in close association with them, both in Mecklenburg, in Germany, and later in Berlin, where I was on the Commandantura with my Russian colleague. Then when I went back over to serve in Germany just a few years ago, I saw a considerable amount of their forces and equipment. Extremely able.

Mr. MCCORMACK. That doesn't include the Red China military manpower?

Lieutenant General GAVIN. No, sir, it does not. That is another matter.

Mr. MCCORMACK. Does that include the satellite, the 175 divisions?

Lieutenant General GAVIN. No, sir, the satellite would give them additional divisions. I am not sure of the number, but it is quite a few. Sometimes we should put our minds to the problem of what is going to happen when tactical nuclear weapons are available in abundance, with the manpower supply they have.

Mr. MCCORMACK. Can you give us any information as to the air strength?

Lieutenant General GAVIN. No, sir; this is a bit out of my territory. I would hestitate to offer any information on that. It is available, I am sure.

Mr. MCCORMACK. I have heard it from sources that I would consider to be dependable and have read it in newspapers, so we will confine it to the newspapers. They have at least 20,000 effective fighting planes of all types. They have perfected the intercontinental plane, haven't they, or do you know?

Lieutenant General GAVIN. I believe they have, sir.

Mr. MCCORMACK. You mentioned reference to the importance of biological and chemical and radiological, and I suppose psychological, too. Is it your opinion that it is imperative that we, in all fields, that we be ahead of the Soviets, or at least be in a comparable position so far as retaliatory power is concerned?

Lieutenant General GAVIN. Unquestionably. I don't see how we can survive otherwise.

Mr. MCCORMACK. And I have been told—I don't know how true it is, General—in the field of biological warfare and chemical, probably a combination of the two, that it is possible to arrive at the point of destructability for a nation where it wouldn't be beyond the realm of probability that they could win a war through those means alone.

Lieutenant General GAVIN. If we lacked an adequate defense or retalitory capacity, they certainly could.

Mr. MCCORMACK. Do you care to comment on this idea that we would never attack? I just don't like that. I don't know why our country should advertise to the Soviets that we would never engage

in aggression or at least let them think we, if they push us around too much, that they might go too far and we would take some action. Have you any thoughts on that?

Lieutenant General GAVIN. No, sir.

Mr. MCCORMACK. I don't like to be wedded to this idea that we are going to be on the receiving end if the first attack comes.

Lieutenant General GAVIN. It is an unpleasant prospect to lose the initiative.

Mr. MCCORMACK. It is most unpleasant. It is dreadful to think of. If I were engaged in a fight, I am not going to let the other fellow sock me the first time. He might knock me out. At least I am not going to let him know I am going to let him have the first punch.

Lieutenant General GAVIN. Your only alternative would be to prepare yourself in defense and be certain to have the power to survive the initial blow.

Mr. MCCORMACK. In other words, to deal with them on the level of law of self-preservation. You can't deal with them morally; you can't deal with them idealistically in this world today. You have to recognize the law of self-preservation; is that right?

Lieutenant General GAVIN. Well, sir, we rather hope that in this day and age civilized man has come to the point where, through his own institutions he can maintain world law and order and without going to the very fundamental, let's say, law of the jungle, where you have just got to attack. I am idealistic enough that I think that the institutions can exist that will enable hem to survive and even withstand a blow and retaliate therefor and resolve the issues in its favor.

Mr. MCCORMACK. I couldn't argue with you on that, General, except my thinking is "out of evil might come good"; that the means of destruction—we won't use them perhaps—but that the means of destruction is so great that it might restrain the use of them and, so to speak, out of evil might come good.

Lieutenant General GAVIN. Yes.

Mr. MCCORMACK. I would interpret your thoughts along that line.

Lieutenant GAVIN. I might say, in my personal opinion, the satellite offers the first hope to humankind of a surveillance system that could guarantee world peace. You know in the military business, men have traditionally brought the resources of their industry and their country into the inventory, continually building up strength in the name of peace, being ready for war and thus peace is to be maintained, but the experience of humanity has been quite the contrary because they inevitably got to war. This has been our experience so far. In the satellite we have a vehicle that could be developed into a worldwide reconnaissance net and, in my opinion, this sort of thing associated with something like the United Nations, under the sponsorship of our country, really could guarantee world peace. I can see the possibilities of this now.

Mr. MCCORMACK. But we have to keep our guard high all during that period.

Lieutenant General GAVIN. Oh, absolutely. No question about it.

Mr. MCCORMACK. In other words, as a military man you wouldn't act upon that supposition in connection with the defense of our country?

Lieutenant General GAVIN. No, sir; I would never counsel such a thing at all and referring again to your comment of a moment ago that out of evil will come good——

Mr. MCCORMACK. Might come good.

Lieutenant General GAVIN. Might come good, and your elaboration of that along these lines, that under this, shall we say, canopy of fear of each other, then there may be less likelihood of war. Well, the thing that concerns me and I would counsel you to concern yourself with this problem, under that canopy of fear will come lesser efforts, other approaches—psychological, economic, limited military, subversive. These are the areas of most promising expansion, in my opinion, and they are more likely now than they were before the evil occurred of mutual terror.

Mr. MCCORMACK. I note that the notes between the Soviet Union and the NATO countries are getting more and more belligerent, and even the utterances of Khrushchev, who is the real head of the Soviet Union, although not officially occupying the official position, if quoted correctly, are getting awfully close and much closer and closer to the point of an ultimatum. Have you observed that?

Lieutenant General GAVIN. Well, I have noted the tenor of the exchanges. It's been a very interesting phenomena starting back, you know, sometime ago, a year or two ago, and when they sent notes to each country at different times about the powers of nuclear weapons, rocket retaliation, and that sort of business. It is very interesting. I think it is not out of pattern with the Soviets. It is what one would expect. If they have a feeling that they are in a position of advantage militarywise in this missille age, let us say, I think we will see a great deal more of that sort of thing. The exchanges will become rather truculent and aggressive, and we will have problems.

Mr. MCCORMACK. Of course with the American people public opinion is an important factor under our form of government and it should be. We all realize that. I think there is no brilliancy in having that thought and making that observation. It is a very powerful factor whether created emotionally or if as a result of emotional strains and reactions and lack of knowledge, often erroneously, in a period that we are undergoing, and I have in mind the days before Pearl Harbor. For example, when the selective service passed by one vote in the House of Representatives. I also have in mind that effective public opinion probably has a lot to do with coordinating actions which brushed aside many difficulties in bringing about a projecting of our satellite. Is it, in your opinion, vitally important that the American people be constantly alert and not get back to an attitude of complacence, not let this satellite deceive us and get back into what I call the dream world, the world of hope?

In other words, is it vitally important that the American people be constantly alert and realize that as long as the Soviet Union or atheistic communism adheres to world revolution we have to make every sacrifice necessary?

Lieutenant General GAVIN. Yes, I think so. There is a tendency to violently fluctuate between depression and elation, it seems to me, and the experience of last weekend, after Explorer went up, is just a little bit disturbing. True those of us in the working business of missiles and satellites, we were quite confident of launching a satellite, and it is an interesting achievement, and it is one now that should

cause us a great deal of concern because, as I said in the beginning, we are going to have to show a lot more wisdom now than we did in getting it up there because now we have to think where we are going and there is no time to be swept away, because we have some very hard decisions to make and it would be a tragedy to figure we have everything behind us now and we are now really out in the front. We are far, far, far from it. We would do well to acquire a more sober, industrious, level-headed attitude, let us say, and hard work.

Mr. McCormack. Well, I like blunt language in these days. I think the American people like to get the facts. Our people have showed we can take the good with the bad, and public opinion is a very important factor. All of us in public life know it. It is honestly entertained, but when it is operating in the field of lack of knowledge and in response to fear and emotionalism, the reaction is usually erroneous—honestly so, but erroneous.

Your opinion and your position that the American people should not lull themselves into a feeling of security, that that would be unwise, that they should keep their guard up, might be a powerful factor in alerting the people of our country to have in their conscious mind always an appreciation of the potential danger as long as the present world tension exists.

Lieutenant General Gavin. Yes, sir.

Mr. McCormack. Any questions now of this witness?

I think it is very fine of you to submit yourself to questions this way. Members of the committee can get to the heart of what they have in their minds and direct their questions to you. I like this way of presentation.

Mr. Brown?

Mr. Brown. General, I have followed with a great deal of interest the line of questioning by the chairman this morning and I agree with what he has said as to the necessity for us to make ourselves strong, and to be prepared to meet any attack which may come. I am wondering if you would like to comment on the possibility of a military stalemate developing?

You recall in World War I Germany, especially, used poisonous gases with great effect in the latter days of the conflict and then the Allies began to develop similar gases; and that between World War I and World War II, every great power developed all types of poisonous gases, so deadly in effect that during World War II, seemingly, no nation dared to use them.

Lieutenant General Gavin. Yes, sir.

Mr. Brown. Now I am wondering if there is a possibility, in your opinion, that we may reach such a position as far as hydrogen and atom bombs are concerned, and guided missiles, and so forth, so that we may reach a stalemate when the realization dawns on even the most stupid heads of government, we will say, that to start World War III would mean annihilation of all people.

Lieutenant General Gavin. Well, sir, that stalemate in World War II was brought about by a capability on both sides to really deliver a devastating blow and we were always ready. I point out even in the Normandy invasion of both forces, the Americans wore impregnated clothing to protect themselves against chemical agents. They carried gas masks. A lot of them left them in the airplanes or parachutes, but they carried them.

Mr. BROWN. Suppose the same situation develops in the new age.

Lieutenant General GAVIN. This, I say, is different because the problem in itself, nuclear business, is not what but why and why do you use power and can it be used as an instrument that will serve your needs. What I am saying is that it will come right down to using fissionable material in such packaged forms that can be used by the military forces and the economics of warfare is such that fissionable material will be used inevitably, in my opinion. It is not a case of having a nuclear force and nonnuclear force; it is a case of having a power. To go right down to the lower echelon of establishment—like the streetcar on the corner—the military uses just enough power and hopes that it won't spread where you don't apply the power.

Mr. BROWN. That doesn't apply to intercontinental ballistic missiles?

Lieutenant General GAVIN. It does this way: You have to develop first intercontinental missiles and equally as fast you have to develop a missile to defend against that missile. Both sides will do that.

Mr. BROWN. That is always the rule of warfare.

Lieutenant General GAVIN. So they are not ultimate weapons, not at all; they are just one more weapon. Beyond that we are into the satellite business. There are people who, in open statements, have stated it would be possible to put a warhead aboard a satellite, and that sort of thing. We may ultimately have to have if we are going to really survive, a capability of denying satellite intrusion over the free world. At least we must have a capability, although we hope some arrangement will be worked out where free satellite travel can be conducted by all people.

Mr. MCCORMACK. Would that be peaceful, sir?

Lieutenant General GAVIN. Yes, peaceful, sir; but you can't tell what is in it.

Mr. MCCORMACK. That is the hope, I mean. You are expressing the hope that it will be confined to peaceful purposes?

Lieutenant General GAVIN. That is right. So I would say that it isn't quite the same thing as the gas and chemical warfare because that was but one thing, and we may stand off with that, we may stand off with the big ballistic missile, but different forms of applied power will be used anyway and, in my opinion, it will be nuclear power.

Mr. BROWN. But suppose both sides develop practically equal strength. Is there a possibility, or perhaps even a likelihood, that as a result of this equality of strength in nuclear warfare that there may be a stalemate, that the realization will dawn that no one can win in a struggle like that? Do you think that may happen? That has been sort of my hope, by the way.

Lieutenant General GAVIN. Yes, there is a likelihood that we can develop a sort of an open-skies plan, using satellites.

Mr. BROWN. Now I would like to ask you this other question, and I hope it won't be misunderstood.

Mr. MCCORMACK. Pardon me. In other words, coming back to out of evil might come good.

Lieutenant General GAVIN. Yes.

Mr. BROWN. That is right, the same philosophy the chairman suggested.

There is a great deal of talk about trying to reach some agreement with the Communist world, and so forth. Is it your opinion that sooner or later, whether it comes before world war III should break, or if there is anyone surviving after world war III, that sooner or later we will have to sit down as human beings and try to work out some kind of an arrangement whereby we can live together in the world?

Lieutenant General GAVIN. Yes.

Mr. BROWN. That has to come, doesn't it?

Lieutenant General GAVIN. It certainly seems to me it must. As an individual I say this.

Mr. BROWN. And it probably would be better to come before world war III. Otherwise we might not have many people left to argue about it.

Lieutenant General GAVIN. You realize, sir, this isn't my field. I don't want to touch upon national policy and such matters.

Mr. BROWN. I understand, but it is still part of the overall problem Congress has to deal with.

Now I would like to go to another line of questioning, if I may. We have the problem before us of what we are to do about an adequate supply of scientists, mathematicians, technicians, and engineers, and so forth. In your opinion, has a shortage of scientists and engineers and technicians slowed down our progress in the missile field, or in the satellite field?

Lieutenant General GAVIN. This is just my opinion.

Mr. BROWN. That is what we want.

Lieutenant General GAVIN. I know there has been a great deal said about this and I don't think it has slowed down much at all so far, but I would be worried about the future, because I have four children of my own and——

Mr. BROWN. You think it is more of a future problem than it is one of today?

Lieutenant General GAVIN. In my opinion that is the case. We have an abundance of good scientists. Maybe they are not distributed properly, their skills, but I must say, as a father of children now going to school and with the knowledge of the work I did in school as a boy, I am concerned with the easy courses they take, the lack of real effort. It is amazing.

Mr. BROWN. As I brought out the other day, can we make the skilled scientists and technicians and engineers we need out of boys who perhaps do not know how to spell, or the meaning of words, or how to read, or much about mathematics?

Lieutenant General GAVIN. Coed cooking, and that.

Mr. BROWN. Well, we had that situation before our committee, too. We have explored that.

Lieutenant General GAVIN. Those who sit in research and development, it just about works out like this: The field is tremendously dynamic now. The whole world we are entering and the number of new ideas is almost a direct function of the number of minds applied to these things. Now a young mind properly trained in physics and math and in the social sciences, too, that comes up to the level of understanding of the phenomena of our time is a very useful person for the Nation to have. If we have, let's say, a thousand of these

and the Soviets have 10,000, chances are they are going to think of 10 times as many things.

This is a little over simplified, but the thing that worries one, in this very dynamic technological world in which we live, is the numbers of minds applied to these powers that we should have, and which the Soviets obviously will have.

Mr. BROWN. You feel a good sound basic education in the fundamental principles, as we know them, in our elementary and high schools of the Nation is a necessary foundation upon which to build higher education upon; that is, the college and graduate work?

Lieutenant General GAVIN. Oh yes, absolutely. Of course I speak as a soldier, because we see the military application, but for the entire betterment of human relations and understanding worldwide, it is essential. The educated man is far more ready to understand and adapt himself to the problems of today than the man who is not. Our prospects would be infinitely better with good sound basic education.

Mr. BROWN. We have the problem that high school and elementary school education comes under the control of the States and local communities; and there is a question as to how far the Congress can dictate or control in such a field. We can only suggest, and so forth and so on, but without taking over—that is, without imposing Federal control over our public education system. Somehow or other there has to be some new method worked out in many of the public schools of this country—perhaps not all, but in many of them—to give youngsters the sound basic education they need.

Let me ask you one other question. You mention here, and I take it it was a quote from your previous testimony before the Armed Services Committee, the decline in the strength of the Army, and the low appropriations therefor. We get a great many letters here in Congress—at least I do, and I am sure the other Members do—from back home in our States as to the way the Defense Department, or the Army, or the Air Force, as the case may be, or the Navy, has been eliminating or discharging Reserve officers. I have one case of a Reserve officer, and I think this was a damnable outrage, who within 4 months of his retirement, and he served very well in 2 wars, was discharged. What can you say as to that? What is the situation? How badly have such actions crippled the Army or the Armed Forces, and what we have been doing in cutting down on our Reserves, and how necessary was it and who did it? What can you tell us about it?

Lieutenant General GAVIN. Sir, I really cannot tell you much that would be worthwhile. I heard it discussed, but it is not exactly the business I work in and I would really respectfully suggest you bring over our top personnel people, either Secretary Milton or General Booth, to talk about that. They could talk to you about it.

Mr. BROWN. You agree, of course, that a strong Reserve is very important to the defense of the country?

Lieutenant General GAVIN. No question about it.

Mr. BROWN. And the Reserve officers and other Reserve personnel played a great part in the winning of World War II.

Lieutenant General GAVIN. That is true.

Mr. BROWN. Now, the same situation seems to exist as to the National Guard. We are getting complaints from our State officials as to the reduction in the strength of the National Guard, and its train-

ing program. The guard, of course, has been the great secondary line of defense in the country.

Lieutenant General GAVIN. Oh, sure. The number of regulars in World War II were very few—very few.

Mr. BROWN. And you can't give us any views on that?

Lieutenant General GAVIN. I hesitate to. It wouldn't be worthwhile.

Mr. BROWN. That has been part of the pattern, hasn't it, to cut the Reserve?

Lieutenant General GAVIN. They have been cut, yes.

Mr. BROWN. And the National Guard, as well as to reduce some of the components in the Army itself, and the number of divisions?

Lieutenant General GAVIN. Yes, this has occurred.

Mr. MCCORMACK. Do you think the Army, assuming it was called upon to engage in what Congressman Michel descriptively referred to or described as a brush warfare—would the Army be able to resume its roles and missions, in your opinion, under its present condition?

Lieutenant General GAVIN. Sir, there are many assumptions you would have to make as to the location and magnitude of brush warfare. We were ready for Korea but it was a rough show for the Army. Ninety-six and a half percent of the casualties were ground forces. We came very late and were doing the best we could with the limited resources.

Mr. MCCORMACK. I think General Walker, who is dead now, did a remarkable job. He hasn't gotten the credit publicly—in the Army circles, he may have, but I don't think publicly he got the credit his leadership called for.

Lieutenant General GAVIN. Yes, I was a personal friend of his. I was his Chief of Staff in the Fifth Army in Chicago, just before he went over there. I went over to see him, as a matter of fact, at the time when things were pretty dark and he was having a very, very difficult time. We survived that. We didn't win Korea; we didn't lose it either, I guess. Only history will tell us. I sometimes wonder where we go from here, if that was a turning back or not, because we cannot afford to go through many more of that sort of thing. It is no good.

Mr. BROWN. We didn't win it, did we?

Lieutenant General GAVIN. We didn't win it.

Mr. BROWN. It is the only war we ever entered into we didn't win.

Lieutenant General GAVIN. That is right, and it was very costly in human life. I wish we were in much better shape. I occasionally use this expression, and I mean it, that we don't bring your sons and your brothers into the Army to die for their country. This isn't the idea at all. We bring them in to so equip them and so train them that if someone else wants to die for his country, why we will accommodate them. We want to bring our young men back home healthy and sound and therefore we become rather disturbed by inadequate resources that face us with the prospect of another Korea.

Mr. BROWN. What was the loss, by the way, of the graduates of West Point in Korea? We lost from that year's class, about two-thirds of them, didn't we?

Lieutenant General GAVIN. I don't have the exact statistics, but it was very high.

Mr. McCormack. General, I am going to ask you some questions about what I read in the newspaper again. I have read that the Soviet Union has perfected an intermediate ballistic missile from anywhere from 700 to 1,000 miles. I have read that in the newspaper.

Lieutenant General Gavin. Yes, sir.

Mr. McCormack. Would you want to comment on what I read in the newspaper?

Lieutenant General Gavin. Well, this is accepted, sir, I believe.

Mr. McCormack. What is that?

Lieutenant General Gavin. I believe this is accepted in our intelligence community, that they do have an intermediate range ballistic missile.

Mr. McCormack. And capable of hitting the target with accuracy?

Lieutenant General Gavin. Yes, sir; this is accepted too.

Mr. McCormack. And they are in production?

Lieutenant General Gavin. Yes, sir.

Mr. McCormack. I have read in the papers that they expect to perfect the intercontinental ballistic missile probably by the end of this year. I have heard by July 1 of this year, and others say the end of this year.

Lieutenant General Gavin. Yes, sir; I read that in the paper, too. I am not sure of the exact date on that and I would hesitate to comment on it, but it is obvious it isn't far away.

Mr. McCormack. The question of production, once they have perfected the other important aspects, is not a difficult matter; is it?

Lieutenant General Gavin. Well, it certainly would normally be difficult for a nontechnical people, but the exceptional competence that they have shown in this aircraft business and so far in their missile business makes quite clear a capability far beyond anything we estimated, say, 10 years ago, they would have. They are doing very well in the missile field.

Again I point out that the missiles that their Army has, that we have seen, are very fine looking missiles. The equipment, the launchers on track-laying gear, missiles that are amphibious, that swim big rivers like the Rhine, and missiles on a track-laying vehicle that fires from the vehicle itself, not on the water, but on the land, the nuclear-warhead carriers and many things of a technical way are impressive of what they are doing.

Mr. McCormack. So when we read from an overall angle that we are ahead, that doesn't necessarily answer the question?

Lieutenant General Gavin. No, sir.

Mr. McCormack. You have to break it down to the key things, where the real damage could be done.

Lieutenant General Gavin. That is right, sir.

Mr. McCormack. And in that field they are ahead of us?

Lieutenant General Gavin. In many areas; yes.

Mr. McCormack. In many areas, General?

Lieutenant General Gavin. Yes, sir.

Mr. McCormack. Particularly in the field of ballistic missiles?

Lieutenant General Gavin. Yes, sir.

Mr. McCormack. Are there further questions?

Mr. Brown. I wonder if the General would comment on how long he thinks it will take this country to catch up with Russia in the missile field?

Lieutenant General GAVIN. Sir, this is so difficult. It is a very difficult question because every man has his own opinion. I have heard the opinion expressed and I have also expressed this opinion, that if we really made an all-out effort for from 5 to 10 years we might show some daylight between ourselves and the Soviets.

Mr. BROWN. Would we be ahead of them in that time?

Lieutenant General GAVIN. Yes; we might.

Mr. BROWN. We ask these questions not to embarrass you, but because so many of us have a great deal of confidence in you, General. You have our respect up here on the Hill.

Lieutenant General GAVIN. Thank you very much. But if we work hard and apply ourselves, we won't show any daylight for at least 5 years. About sometime around there we might, if we work hard enough.

Mr. MCCORMACK. That is rather a long period.

Lieutenant General GAVIN. Yes; a period of great danger.

Mr. MICHEL. General, the other day I engaged a friend of mine in a discussion about a so-called clean bomb and he was quite concerned and said "what do you worry about a clean bomb for: it still has all the destructive force and the horror of war." I said, "Isn't it conceivable by the development of a clean bomb that we might very well use it for our own defense, rather than a destructive force," meaning to use it above ourselves to repell stuff coming in. Was that completely out of reason to think of it in those terms?

Lieutenant General GAVIN. No. I have Colonel Cowan with me and I would like you to talk with him about that because that is his specialty, and this, of course, is an open hearing.

Colonel COWAN. I might say, sir, there are times when you could develop a military situation where the fallout from a weapon would be to your advantage, such as an area of denial—something like that. Under a particular military situation you could do this. However certainly in the field you represented (air defense) we would not want our own fallout, for example, from our defensive atomic weapons to endanger our own cities. As a matter of fact, I think it is safe to say that with the Nike-Hercules employment within this program, I don't think the fallout will be a danger. But certainly it would be desirable to develop a clean weapon for this purpose because it would allow us not to have the risk of fallout and, for a tactical situation with our own forces, it gives us a great deal more flexibility in employment. For example, if we have fallout from the detonation of our own weapons, this might deny our own movement into an area. So a clean weapon is desirable from the point of view that it gives us military flexibility, although there are certain situations where you could use fallout to your own advantage. Certainly we want to get on with the job of developing a clean weapon as soon as possible.

Mr. MICHEL. I appreciate the colonel's explanation.

There are a number of things we allow for for security purposes and at times we skirt the issues and we don't even talk about them and I think there are things we have to think about in the future and we might very well sow the seeds among the general public so they get accustomed to this, what we might do and what might be required. It isn't a terrible thing you folks have foreseen, and we have to do our utmost and use utmost care in the development of those.

Lieutenant General GAVIN. I agree. The day is not far away when we will have nuclear weapons around many populated areas and all over the country. We take for granted that they are going to be used. There is nothing dangerous or horrible about them on the ground. It is just a case of normal usage in the passage of time.

Mr. POLAND. I understood that in matters of immediate import, which are most critical, one would be the facility of decision, that there are delays in decision making, and another would be constriction in obtaining the money, due to attritions or allocation. Do you care to amplify those statements as to the other matters of immediate concern, critical concern, in relation to your research and development activities?

Lieutenant General GAVIN. Sir, I think they are the most important things from the viewpoint of the Department of the Army. There may be other things, from the national point of view, on which I am not qualified to comment, but from where I sit and knowing the problems I have, the faster decision making, adequate resources put on the promising programs and decisions to eliminate, as well as to start, are very essential. If we deal with these problems adequately, we will move along all right.

Mr. POLAND. Do you care to suggest the means which might be taken to facilitate decision making? Are they organizational or management or both?

Lieutenant General GAVIN. Well, they are both, sir.

Mr. POLAND. Do you care to make any suggestions as to the best way to eliminate them?

Lieutenant General GAVIN. I would rather not go into detail, sir. I think the Department of Defense is looking into this thing now. I know that Mr. McElroy is and I expect things will be done to improve the situation significantly in the next 6 months or so. Even the structure of the Joint Chiefs, I believe, will be looked at. This has been in the press. I presume this is the case, and out of there will come an improved situation. In fact, I would rather not go into detail for a number of reasons. One is it is being looked at by the people who have the competence to be looking.

Mr. POLAND. I know the chairman doesn't want any questions that would embarrass you and I didn't want to ask one which would. But to get to the matter of money——

Mr. MCCORMACK. Just a minute. It is not the embarrassing questions, but that they don't go into items of a classified nature. I wouldn't want anyone to think the Chair was arbitrary.

Mr. POLAND. With that qualification, then, by the chairman, do you care to point out the areas where you get what might be called constrictions in the budgetary pipeline? You mentioned already, I believe, the fact that the expenditure of money for one project might diminish the availability of that money for another.

Lieutenant General GAVIN. Yes.

Mr. POLAND. Do you care to add to that, to indicate where you are getting financial constrictions or difficulties?

Lieutenant General GAVIN. Sir, in research and development we have asked for significantly more money for the past 2 years, and this has been in the open record, than we have received. Last year, $596; this year, $584. Last year there was made available, roughly, $355 out of an expressed need of $596.

Mr. McCormack. This is millions, is it?

Lieutenant General Gavin. Millions, yes, sir.

Now, coupled with this, you have the dollar value changing and we, therefore, have a diminishing effort being made at a time of increased costs and greater challenge and greater danger and it means then that you cut quite a few of your programs and accept slippage as a normal thing in a number of areas where we wish we were moving faster.

Now it is beginning to appear this situation might be remedied next year. I suppose one of the things that worried us most was the missile to defend against the ballistic missile because we in the Army have been working on this for several years and we have had a hard time really convincing people that this was a sound program, but it seems to be now coming out of the woods and I hope we get enough money for it next year. This is a very important program to the country. We must be able to defend against missiles.

Now, for example, we have the problem of defending against a short-range missile, which is a very difficult one, more difficult than defending against a long-range missile. This will require adequate funding. You have many problems. I mentioned the Goer problem, the compression ignition engine, which is a very important one. We use a carburetion system in our tank engines which gives us significantly less miles than the Soviets get out of theirs. We have been pushing this program with a rather limited funding for several years. I hope, however, to move along a little faster next year on it, but the entire program, I think, could stand better funding than it has been getting and it isn't a specific thing so much, except in the few instances I have mentioned, as it is the overall problems of slippage.

Mr. McCormack. Mr. Lanigan.

Mr. Lanigan. Is your problem in funding in being allowed to make the request for funds from Congress that you believe are needed or is it in fact that Congress isn't appropriating as much as requested?

Lieutenant General Gavin. Congress has appropriated as much as I have requested, since I have been in the job.

Mr. Lanigan. So you have not had any problem so far as Congress is concerned?

Lieutenant General Gavin. No, sir.

Mr. Brown. As much as requested, or as much as was in the budget?

Lieutenant General Gavin. As much as I have requested of the Congress in defense of my budget, so it was what was in the budget.

Mr. Brown. May I just comment, as a matter of record, Mr. Chairman, that so far as I can recall the only instances in which the Hoover Commission made any recommendation for the spending of more money was in late 1955, when the Commission recommended there be increased activity and spending in research and development within the military forces.

Lieutenant General Gavin. Yes.

Mr. McCormack. I think the Hoover Commission Task Force on Research and Development said in part—

> Research and development occupy a unique position in building the Nation's military strength. * * * The pattern of our warfare is determined by the character of the weapons system. Our strategy and tactics can be superior to those of our potential enemy only to the extent that our research and development provide superior weapons designs.

Close coupling of military research and development with the advancing frontiers of science and technology is essential to our maintaining a superior position in weaponry. The time interval between the availability of a radically new weapon and the new scientific knowledge that makes it possible must be reduced to a minimum. To realize close coupling and rapid tempo, all elements of the Nation's scientific and technical community must be integrated in its military research and development programs.

We will put that in the record in view of your question of support of those.

Mr. BROWN. I have it somewhere, but the Commission itself made a definite recommendation to that effect, and I think it well that the record so show that at his point.

Mr. MCCORMACK. Without objection, it will be made a part of the record.

The recommendations referred to by Congressman Brown are as follows:

Hoover Commission Report on Research and Development in the Government, page 15:

"Task force subcommittee recommendation No. 8: That the level of basic research in the Department of Defense be significantly increased above its present $20 million level of annual expenditure."

Page 31:

"Commission recommendation No. 1: We earnestly commend the administrative recommendations of the task force subcommittee to the Department officials concerned."

Mr. LANIGAN. The Army supplied some information to the committee which was received just yesterday, and I have not had time to check it before last night. It indicates that the Army research and development budget submission, that is, the Army's request to the Office of the Secretary of Defense, had dropped in the case of basic research from $34 million in 1953 to $28 million in 1958. In the case of applied research, it dropped from $74 million in 1953 to $51 million in 1958, and in the case of development, it dropped from $382 million to $291 million in 1957 and then went over the old figure to $487 million in 1958.

Now have these Army requests to the Office of the Secretary of Defense reflected the true thoughts of the people working in research and development as to the needs or do they reflect some sort of a budget limitation that has been put on the Army?

Lieutenant General GAVIN. Well, sir, adding those figures up, it strikes me that what you have there are the figures that I have been authorized to come to the Congress and defend. I am not sure of your gross figures out of which they came, and I don't have that sort of breakdown.

Colonel DEANE. I could show you that.

Mr. LANIGAN. Of course this was supplied by the Secretary of the Army.

Lieutenant General GAVIN. Those are the figures that we have to defend; they are not what I asked.

Mr. LANIGAN. Were you directed to defend these by the Secretary of Defense Office or by the Secretary of Army Office?

Lieutenant General GAVIN. Well, by the Chief of Staff, speaking for the Secretary of Army.

I may apply for what I consider an adequate funding, which I have done, and I also have authority to tell this committee that I have so applied and this is considered in relationship to the overall defense

problem, and then I am told what money I will get and that is what these figures are.

Mr. LANIGAN. I am a little curious because one of the questions asked the Army was how much had been requested at all levels and apparently we didn't get the complete information because the beginning figures that they gave us were the figures that you have before you.

Lieutenant General GAVIN. There may be some misunderstanding. For example, I just singled out the 1957 figure here and it totals up to 373. Well, this is what I have actually been given, what I came up here on the Hill to defend, not what I asked. The 1958 figure, for example, is—I am not sure of these figures. The 1958 amount adds up to the money I asked for and it was the gross amount I asked for. It is 566. Now the 1957 money is just 373.

Colonel DEANE. May I inject myself here, sir?

The question as posed to the Army by the committee dealt with areas which are somewhat different from the figures General Gavin has been using. In 1958, for example, we have used the total requested for the Army only for the fiscal year 1958. This includes not only the money which was appropriated for the Army this past year by the Congress, but all money that the Army originally requested, you see, so the figure totals up to a much greater amount than the figure which General Gavin referred to as having been defended before the Congress.

Mr. LANIGAN. Now we also asked for information about the stopping and starting of the availability of money and the withholding of funds after they had been appropriated due to other considerations. The Secretary's Office informs us in 1957 $26 million of your research and development funds were withheld and not made available to you until the 1958 fiscal year. In 1958 you have indicated that there was a reserve set up of $17 million, apparently in the Treasury or the Bureau of the Budget, and also initially there was a 10 percent cut in the moneys that were made available to you after they were actually appropriated. Later on, when the secretaryship changed, I believe early in this year, some of that money was restored. Have you found that this withholding of money after it has been appropriated has been a troublesome problem in your planning and carrying on your research and development activity?

Lieutenant General GAVIN. Very much so.

Mr. LANIGAN. Would you explain why that is so?

Lieutenant General GAVIN. Well, take last year, for example, $17 million was withheld. Now I had to plan on some figure so I used $372 million as my planning figure last year. I had my program directors in. We went to work and laid out our programs and decided the amount of effort we would make in each area. There was a certain amount of decision making there as to what you would cut back on and perhaps eliminate and so on. This takes quite a bit of effort and then we came up to the Congress and defended that figure and finally when I got back, I lost $17 million of that.

Mr. LANIGAN. You mean after it was appropriated?

Lieutenant General GAVIN. Yes. Now, there is an honest area of doubt as to whether—as I understand the situation—whether or not I should have assumed we would get this. I heard rumors I wasn't going to get it, but I was told by the Secretary of the Army to defend

372 and plan on its use. When I got my money, $13.8 million was taken out of that to support Jupiter, and I had been assured Jupiter would be supported out of Department of Defense emergency funds and not out of my 372; so, I had to go back and reprogram and cut here and there. We were down so low in funding that this was a very painful decision. Our program isn't fat in the Army at all. We are having a hard time. So, it is a very difficult thing to do. So, gentlemen in answer to your first question, it is difficult to have to reprogram after you do it once and plan a certain way and then you have to go through the whole process all over.

Mr. LANIGAN. Some of the witnesses who have appeared before the committee have indicated that a serious problem was also caused in the case of contractors who were doing the work, because they were suddenly told that money was not available and they break up teams and facilities and later on, maybe, money is suddenly made available again, but the whole project has to be restarted and a lot of the work redone. Have you found that this is the case, that your contractors have suffered and your expenses have been raised by this stopping and starting of funds?

Lieutenant General GAVIN. Yes. I say, from talking to industry, that this is the case. It is difficult for them. You see, they don't want to let a good team of scientists go, and the diminishing money causes such things. They come and talk to me about the prospects, and it is very difficult for them. Sometimes, when they let them go, money does become available, and then they can't get them back, and it is very difficult to maintain continuity of effort under these year-by-year businesses. It is very difficult.

Mr. LANIGAN. Do you have any specific examples in mind where this impact has been so damaging in the way you describe?

Lieutenant General GAVIN. Well, I prefer, and I could provide examples, to have people come in who could give you examples from my technical service; the people who do the direct contracting, for example. My office doesn't.

Mr. LANIGAN. Perhaps they could be submitted in writing by your staff, if you could do that.

Lieutenant General GAVIN. I will do that.

(The following material was subsequently furnished by General Gavin's staff:)

EXAMPLES OF PROBLEMS CAUSED BY THE FLUCTUATING AVAILABILITY OF FUNDS

Due to expenditure limitations placed upon the Army by the Department of Defense, no research and development contracts citing fiscal year 1958 funds were awarded in the ground-mobility program during the first 6 months of the fiscal year.

In the area of quartermaster research and development, it has been necessary to extend the completion date of 69 contracts. This is resulting in delays ranging from 2 months to 1 year in meeting schedules for completion of 23 research tasks and 46 developmental items. This involves such areas as simplified food logistics components, radiation preservation of food, and rough terrain forklift tractors.

In addition, it was necessary in the engineer research and development program to withhold the awarding of new contracts citing fiscal year 1958 funds which would have resulted in expenditures in the first half of the fiscal year. This slowed progress in the fields of mine detection, mobility, and target location as award of the following contracts was deferred 3 to 6 months:

Electromagnetic consultants conference
Data-processing computer for Dixie

Nuclear light source study
Research on new temperature-sensitive phosphors
Floating storage base terminal
Automatic controls for 12-inch high-pressure pumping unit
Standard filter-separator design
Development of improved engine acessories

Mr. LANIGAN. I have two other questions. One, how does it happen that the Army was pretty much ready to send up a Jupiter-C on about 3 or 4 months' notice when we have had testimony here that, 2 years before, there had been an advisory board meeting and there had been a divided vote and the project had finally been assigned to the Navy, and Navy had worked on a different type of satellite, different shape. Now, on a very short notice, the Army has all of this assembled and ready. Did the Army go right ahead or just what happened?

Lieutenant General GAVIN. No. It worked out like this: Our development team, headed by Dr. von Braun, made a decision at the very beginning of the Jupiter program that they would prove out Jupiter components and their philosophy of development by using the Redstone missile and other available hardware. One of the most sensitive items was the nose cone.

Mr. LANIGAN. Could you give the approximate date as you go along?

Lieutenant General GAVIN. This decision was made on his part in the spring of 1955, when we proposed our program. We thought through an IRBM, a Jupiter program, in the spring of 1955. When we got authority, a decision from the Secretary of Defense in November of 1955 to go ahead, we included in the Jupiter program a number of missiles, subsequently known as Jupiter-C missiles, that had only one purpose, and that was to fire a nose cone that would reenter the atmosphere under conditions approximating those of the big Jupiter. Now, that is all this missile was to do, and we used a small Redstone as a main thrust unit and it had the nose on it.

I remember when Dr. von Braun made that proposal. It was a rather, well, shall I say, extreme idea. Most of the industry was thinking of shock tubes and that sort of thing to generate conditions in the laboratory and then extrapolate from those to a big nose cone. He was going to go out—he had done a great deal of work, as a matter of fact, and, on a very austere basis, down at Redstone Arsenal and had a pretty good idea what it would consist of, so he was going to go out and fire one and bring it back and recover it. He set out to do this, and he did. He thought it would take, as I recall, about 11 missiles. It didn't. It took only three. So, when he got his nose cone back, the one put on television, he, in effect, had licked his nose-cone problem and we had 8 missiles, in various stages of assembly, left over that had a capability of going into outer space, you see.

Mr. LANIGAN. When was this?

Lieutenant General GAVIN. Well, I think his nose-cone recovery was in the summer of last year. It was August 8, 1957. But, you see, he had fired a Jupiter-C in September of 1956 without a nose cone. That one in September 1956 went 3,355 miles in range and 682 miles in altitude. After that firing, we were sure, if given the mission, we could launch a satellite for the country.

Mr. LANIGAN. Did the test missile that Dr. von Braun used include the combination of——

Lieutenant General GAVIN. It included right up to three stages. The satellite launched Friday night had a fourth stage, which is the one flying overhead, still attached to the body. It included the three stages, and it didn't have the last one to put it out on orbit.

Mr. LANIGAN. Was that last stage constituted between November of 1957 and the present time?

Lieutenant General GAVIN. I am not sure, sir, but the tin can at the top—we will call it the canister—has in it a number of rockets and they are all identical. So all you had to do was add one more.

Mr. LANIGAN. How can the research and development effort of the Army contribute to meeting this peripheral type of pressure which you are most fearful of?

Lieutenant General GAVIN. Well, it certainly can contribute because this is our business—land warfare—and there is as a big a revolution in land warfare today as there is, in my opinion, in—what shall we say—space exploration and missilery. Let's put it this way. The character of war in the future would be related to World War II variety somewhat like you would relate World War I to the Civil War. You must expect that magnitude of change. The forms of mobility we are now coming upon are far beyond anything we have known in the past. The nuclear weapons brought down to small size and useful as direct support of land operations imply a tremendous change. The powers of communication have grown and missiles have, and all integrated into effective systems means if we are going to deal adequately with the peripheral war we probably better have the type of establishment that can do it. It means a force ultramodern and ready for the type of action we will have. It isn't going to be a World War II and Korean type action, not if the Soviets use the sort of equipment they showed us on November 7.

Mr. LANIGAN. You indicated that rising prices was a problem, but I wonder if you made any study or have anything yourself which would indicate to what extent the rise in prices in hardware and scientists to work on your project has affected research and development. I have in mind the fact that you say you get $400 million today. How much work can you do with that compared with 5 or 6 years ago?

Lieutenant General GAVIN. I think I have that exact figure here. We have worked that out a number of times. It is surprising, really. We have taken the figures—well, Mr. Wilson used figures about a year ago with the press. It varied from around 11 to 16 percent, depending upon whether you were dealing with hard goods or scientific help.

Colonel Deane is digging it up here.

Mr. MCCORMACK. Do you want to put that in the record?

Lieutenant General GAVIN. Suppose I provide it for the record.

Mr. MCCORMACK. All right.

Colonel DEANE. I can read it, if you like, sir.

In order to maintain a level of research and development effort comparable to that we had in 1955, we would have to have, in fiscal 1958, an additional $103 million.

Lieutenant General GAVIN. Over what?

Colonel DEANE. This is over what we had in our budget of $372, which we defended before the Congress this past spring, a year ago.

Mr. McCormack. You say which you defended. That means you felt you ought to have more?

Colonel Deane. Yes; but that was what we defended, sir.

Mr. Lanigan. It takes almost 25 percent more today at the same base?

Colonel Deane. That is what we figure; yes, sir.

Mr. McCormack. Without new projects?

Colonel Deane. To stay at the same level of effort.

Mr. Lanigan. On the basis of the budget you have for this year; that is, fiscal 1958, are you able to perform as much or more or less work than you were able to perform in 1955?

Colonel Deane. Less, sir.

Mr. Lanigan. To what extent?

Colonel Deane. As I say, we need $103 million for this year, fiscal 1958, to perform the same level of effort as we did in 1955.

Mr. Lanigan. How do the dollars you got compare?

Colonel Deane. We had, in 1955, $329 million and this year we had $357 million for our own program.

Mr. McCormack. Any further questions.

Mr. Meader. I just wanted to ask whether any improved techniques in research and development might offset that 25-percent increase. Any computers or new devices? Is there any way of appraising that?

Lieutenant General Gavin. A diminishment of effort, a steady diminishment of effort, in my opinion, sir. It gets more costly rather than less.

Mr. McCormack. Any further questions?

General, we appreciate very much your appearing before us, and also those who accompanied you, and whatever your future years are, we wish you and yours every happiness and success.

Lieutenant General Gavin. Thank you very much. My heart is with national defense and I am going to do all I can to contribute as much as my God-given resources will allow. We all must do that.

Mr. McCormack. I know that, because you are a dedicated man.

Now the next witness we have is Dr. Hovde, but I don't think we ought to call him at this time. It is now a quarter of 12 and with the House meeting at 12, we should probably recess. I had a quick conference with Dr. Hovde and he has to leave this afternoon. I think the committee should adjust to his necessities and convenience. I am going to ask the subcommittee to meet here at 2 o'clock. I would like to have not only the members who are here, but I would like to have the staff contact other members and to have them here, and with all of my multiple duties as a member of the committee and acting as chairman of the subcommittee and leader of the House, I intend to be here. So I appreciate Dr. Hovde's cooperation with the subcommittee.

(Whereupon, at 11:56 a. m., the subcommittee recessed, to reconvene at 2 p. m., the same day.)

AFTERNOON SESSION

Mr. McCormack (presiding). The subcommittee will come to order.

The next witness is Dr. Frederick L. Hovde, president of Purdue University, Lafayette, Ind., and chairman of the Army Scientific Advisory Panel.

We will be very glad to hear from you. It is an honor to have you before us.

STATEMENT OF FREDERICK L. HOVDE, PRESIDENT, PURDUE UNIVERSITY, LAFAYETTE, IND., AND CHAIRMAN OF THE ARMY SCIENTIFIC ADVISORY PANEL

Mr. HOVDE. I prepared a short statement, Mr. Chairman, but before I read it I should like to say that this statement of mine represents a set of objectives which somehow I think we should try to attain in the Government operations associated with defense, and that the attainment of these objectives will require considerable study and analysis and action on the part of Congress and the executive branches of our Government.

With your permission I will proceed to read this statement and if anybody wishes to ask questions concerning this, they may.

In his letter of invitation to me dated January 14, 1958, Congressman William L. Dawson, chairman of the House Committee on Government Operations, indicated it was the committee's desire at this time to establish a background of opinion and data concerning the budgetary, organizational, and management aspects of the Government's scientific research and development program.

While the committee's responsibility extends over the whole of the Federal Government's operations, I shall confine my statement today to my personal views and opinions concerning the military research and development phase of Government operations, since I have been both directly and indirectly connected with military science and technology since 1941.

(1) The lessons of World War II, the Korean war, and subsequent events indicate clearly that the application of science to warfare has reached the stage where the principal guaranty of our national security in the years to come is the maintenance of our national scientific and technological superiority. This goal must, therefore, receive top priority in all our thinking and action.

(2) The quality of the Nation's scientific and technological performance cannot be secured nor long maintained unless the source from which all our scientific strength comes is nourished and encouraged—namely, national progress in basic research and the advanced education of our talented young people who have the ability and motivation to become the creative scientists and engineers of the future.

Unless this is done, the armed services, no matter what form their organization and management may take, will be unable to discharge their future responsibilities for national defense.

For the long run ahead, therefore, the Department of Defense and other related Federal agencies must have the means and methods to support a more substantial national effort in fundamental research and in the training of qualified students to enter the scientific corps of the Nation.

(3) The place of our research and development program and its management within the structure of national defense has evolved during the past 18 years from that of a relatively minor operation

to one now at the highest levels of importance and executive control.

The management of research and development programs is still a new and evolving art. As this type of special management has evolved, many mistakes in organization, budgetary control, and decision making have been made, primarily because attempts were made to manage the research and development program in the same way that other types of programs had been managed in the past.

It is both wise and necessary that we constantly study and examine the management and operating structure of our research and development effort.

This should be done by careful and continuous analytical assessment on the part of our executives and scientists with the objective of eliminating that which experience has taught us is inefficient, slow, and wasteful in our present system and methods.

The record of our performance in military science and technology is, on the whole, an excellent one; and hysterical action leading to major changes in organizational structure and command may well result in more confusion and real injury to that which has already proved to be good and productive in our existing defense-management system.

(4) Whatever failures and weaknesses may exist, I believe they are primarily those of management which result in delays in decision making and confusion in the direction of our technological forces. A thorough and careful diagnosis of our failures in management must be made by competent authorities before useful remedies can be prescribed. I believe the major deficiencies in the defense research and development management system can be eliminated without destroying the entire structure.

(5) In my judgment, the first step to be taken with respect to the Department of Defense and the armed services should be a reexamination, with subsequent redefinition and clarification, of the individual roles and missions of the services in the light of present and predictable future conditions. Until this is done, it is impossible for the management of each of the armed services to know clearly and unequivocally what its respective responsibilities are.

When the individual roles and missions of the services are so clarified, then I believe each service must have freedom and authority to carry out the research and development efforts necessary to discharge its responsibilities. Each of the armed services is in itself an operation so gigantic and so important to national defense that nothing should be allowed to interfere with the work each must do to accomplish its mission successfully, except, of course, the budgetary limitation imposed by the amount the Nation can afford to spend on its military defense.

(6) There are several types of defense missions which require the support and collaboration of two or more of the armed services, e. g., continental air defense. Such types of missions involving two or more services should be restudied with a view to more careful definition of responsibility and authority to the services involved and agreements reached between the cooperating services for an effective mechanism for directing the research and development effort to support such dual defense missions.

(7) I believe an organized effort should be undertaken by the Armed Forces to study the present management procedure of de-

cisionmaking with special reference to the research and development programs of the armed services. In such a study, the objectives to be sought are:

(*a*) To establish a management system which avoids present confusion concerning authority and responsibility;

(*b*) To enable the Armed Forces to support research and development projects at optimum rates and reduce the timelag between conception and use of new weapons;

(*c*) To establish a mechanism to insure decisions early in the development stage of new weapons systems in order to stop wasteful expenditure of money, men, and facilities when further investment will result only in marginal improvements or obsolete weapons;

(*d*) To eliminate that duplication of effort which leads to inefficient use of time, money, and manpower, but at the same time retain the freedom to pursue the multiple research and development approach to all high-priority problems and needs. Competitive projects involving different approaches to the solution of military problems in the research and exploratory stages are not expensive and must be encouraged.

(8) Finally, in my opinion, there must be at our highest Government levels, both in the Congress and in the executive branches, recognition and understanding of the real impact, significance, and meaning of science and technology not only to national defense, but also to our industrial and agricultural economy.

The beginning step in this direction has already occurred with the appointment of Dr. Killian as special science adviser to the President and the formation of a science advisory committee under Dr. Killian's chairmanship.

This represents a series of general objectives which I think should be sought in an attempt to approach the reorganization, redefinition, refinement, and redirection of our Nation's scientific and technological effort in the military field.

I am open to questions, if you have them.

Mr. McCormack. I want to compliment you. I have been 30 years in Congress and this is one of the finest presentations, right to the point, that I have ever seen or I have ever heard.

I could just read this and I could end there because it conveys to me a complete picture as to probably what the important things for the Congress and the executive are to do in this important field.

There may be some questions of a clarifying nature that some of us might ask you, in amplification of your excellent statement.

I want to congratulate you, and I know that I speak for the other members of the subcommittee in doing so.

In your statement on page 3, you say:

> Whatever failures and weaknesses may exist, I believe they are primarily those of management which result in delays in decisionmaking and confusion in the direction of our technological forces.

You are chairman of the Army scientific advisory panel; is that correct, sir? And has your panel considered in recent months the question of weaknesses that might exist and made recommendations as to how they might be cured?

Mr. Hovde. You might remember that my panel is primarily organized and convened to serve as an advisory group to the research

and development arm of the United States Army. We have every freedom to say and think and do what we please with respect to development within the Army system.

Our powers of recommendation, our powers of action are limited primarily to advice to Secretary Brucker and General Gavin who heads the Army program of research and development.

Actually, from the panel's point of view the management structure within the Army at the present time is the finest I have ever seen, since my first acquaintance with military science and technology beginning with World War I. It is a structure which has finally evolved after 17 or 18 years with the placement of the command of the research and development function at the Chief of Staff level. So, finally, after 17 years of constant reorganization, the management of the Army's program has reached the point where it now has, in my judgment, and in that of the men who make up the advisory panel, the finest form of organization the Army has had since its formation. This management structure within the Army itself is a good one, as evidenced by its performance.

Mr. McCormack. Some time last year, in October, did your panel have a meeting?

Mr. Hovde. The full panel of some 50 men meets twice a year. And we always meet at one of the major Army research and development stations outside of Washington. The work of the panel is done by subgroups, consisting of seven men, convened to tackle specific problems of research on which General Gavin, on which any of the technical branches of the Army want advice, analysis, and consideration.

The last meeting was at Fort Bliss in October shortly after sputnik. At that time all of us were deeply worried about the meaning of the sputnik and the outward evidence of Russian competence in the field of guided missiles, especially long-range intercontinental ballistic missiles.

Mr. McCormack. Did you make recommendations to Secretary Brucker?

Mr. Hovde. At that time the panel in executive session attempted to place down in writing a set of objectives which would form guidance to the Army in any part it had to play or any advice it might be asked to give with respect to reorganization.

It was our view at that time, in October—a unanimous view, I might say—that we wanted the approach to the reorganization done carefully, competently, slowly, wisely; and we did not want to see people rushing every which way, saying everything was bad, when we knew there was much about the defense structure that is very, very good.

And consequently, we phrased our recommendations in the form of a letter to Secretary Brucker, whom we are constituted to advise. But what Secretary Brucker and his staff do with our recommendations is up to him.

Mr. McCormack. And on October 30, 1957, you as chairman of the board sent a letter to Secretary Brucker?

Mr. Hovde. That is true.

Mr. McCormack. That represented the unanimous view of the panel; is that correct?

Mr. Hovde. That is correct.

Mr. McCormack. Is there any objection to the list of the members of your panel being incorporated in the record?

Mr. HOVDE. None whatsoever.

Mr. MCCORMACK. Have you got it?

Mr. LANIGAN. No, sir.

Mr. HOVDE. We could easily provide it.

Mr. MCCORMACK. I have a list.

Mr. HOVDE. General Gavin's office can supply it.

Mr. MCCORMACK. Will you see that that list is provided and put it in the record?

Mr. LANIGAN. Very well, sir.

Mr. MCCORMACK. Is there any objection to the letter that you sent to Secretary Brucker, of a classified status, to its being made a part of the record?

Mr. HOVDE. It is not confidential in the sense of giving secret military information, but I don't know the propriety of my giving permission for a letter to be put in the record that was addressed to the Secretary.

Mr. MCCORMACK. It is not classified?

Mr. HOVDE. No.

Mr. MCCORMACK. Have you got it?

Mr. LANIGAN. Here is a copy.

Mr. MCCORMACK. I am not going to ask you about that. You say it is not classified. Will you show that to Dr. Hovde and ask him if that is a copy of the report, the letter that was sent?

Mr. HOVDE. Yes.

Mr. MCCORMACK. Not being classified, without objection this letter is made a part of the record at this point.

(The letter, dated October 30, 1957, is as follows:)

ARMY SCIENTIFIC ADVISORY PANEL

DEPARTMENT OF THE ARMY,
RESEARCH AND DEVELOPMENT,
Washington, D. C., October 30, 1957.

The Honorable WILBER M. BRUCKER,
Secretary of the Army, Washington, D. C.

MY DEAR MR. SECRETARY: At this time, when military implications of science are so much in the public mind, you may have special opportunity to express the Army's views about reassessment of our national defense research and development program. As an aid in formulating those views, your Scientific Advisory Panel offers the following discussion:

The application of science to warfare has reached the stage where the principal guarantee of national security in the years ahead is the maintenance of scientific and technological superiority.

Revision of the management and operating structure of our research and development effort should be accomplished through careful analytical assessment on the part of our leaders and representatives with the objective of eliminating that which experience has taught us is inefficient, slow, and wasteful in our present system. Hysterical action or overhasty reorganization may result in confusion and real injury to that which is already good and productive in our existing defense system.

The problem before the Nation is not simply one of money, facilities, nor even men—these we have in substantial amounts and that which we don't have can be provided.

Whatever the failures may be, they are primarily those of management—in which we have a share—which result in delays in decisionmaking and confusion in the direction of our technological forces. Despite rapidly developing pressures for immediate reorganization, a thorough diagnosis of our management ills must be made before remedies are prescribed.

We believe the Army's position in such a reassessment must be clear, unequivocal, and stated in terms that both our leaders and our citizens can understand and support.

The objectives can be stated—there are major deficiencies in our research and development management system which must be eliminated without destroying the entire structure.

The Army Scientific Advisory Panel recommends unanimously that the Department of the Army support proposals and actions which will produce the following results with respect to the management of science and technology for national defense:

I. (*a*) A redefinition and clarification of individual roles and missions of the services in areas where this is possible in the light of present and predictable conditions.

(*b*) Freedom and authority for each service to carry out research and development effort necessary to discharge its obligations as delegated in its individual mission.

(*c*) A clearcut recognition and definition of national missions which require the support of two or more services—continental air defense is an example.

(*d*) An effective mechanism for directing research and development effort to support these national missions.

II. Recognition and understanding at the highest Government levels of the real impact, significance, and meaning of science and technology to national defense, with continual review.

III. Improvement, through reexamination, definition, and organization, of the management procedure of "decisionmaking" throughout the whole structure of national defense:

(*a*) To avoid present confusions concerning authority and responsibility.

(*b*) To support "projects" at optimum rates and reduce time lag between the conception and use of new weapons.

(*c*) To permit decisions early in the development stage, thereby stopping expenditure of money, men, and facilities when further investments will result in marginal improvements or obsolete weapons.

(*d*) To eliminate that "duplication" of effort which leads to inefficient use of time, money, and manpower, retaining the advantages that accrue from multiple approach to high priority development programs in their early stages of evolution.

IV. Technological superiority cannot be secured nor long maintained unless the source from which all our future scientific strength comes is nourished and encouraged—namely, national progress in basic research and the advanced education of those of our talented young people who can become the scientists and engineers of the future.

Neither the Army nor the other services will be able to discharge their future responsibilities for national defense if means are not found, by the Department of Defense or other agencies, to support a more substantial effort in fundamental research and in the training of qualified students.

The Army Scientific Advisory Panel believes these objectives are sound and attainable, and all members of the panel stand ready to assist you in achieving them.

Yours respectfully,

FREDERICK L. HOVDE,
Chairman, Army Scientific Advisory Panel.

Mr. MCCORMACK. Well, in your letter to him of October 30—Secretary Brucker—you said among other things:

Whatever the failures may be, they are primarily those of management—in which we have a share—which result in delays in decisionmaking and confusion in the direction of our technological forces.

Is that right?

Mr. HOVDE. Yes.

Mr. MCCORMACK. Then you go ahead and give a number of recommendations as to how they can be improved:

A redefinition and classification of individual rules and missions of the services in areas where this is possible in the light of present and predictable conditions.

Freedom and authority for each service to carry out research and development effort necessary to discharge its obligations as detailed in its individual mission.

And then it mentions others in the letter which are a part of the record.

Are there any questions?

Mr. DAWSON. No questions.

Mr. MCCORMACK. Mrs. Granahan?

Mrs. GRANAHAN. I have none, Mr. Chairman.

Mr. MCCORMACK. Mr. Poland, any questions?

Mr. POLAND. You said in your statement today, and indicated in your letter, that the management of research development programs is the essential phase and you mention there have been many mistakes in organization, budgetary control, and decisionmaking, and that it has been slow and inefficient and wasteful in our present system and methods.

It is the business of this committee to ascertain means to promote efficiency and economy.

In assistance to this committee will you illustrate what you mean?

Mr. HOVDE. We should talk about the management of research on the one hand and development on the other. This distinction must be made.

One thing people do not generally understand is that you cannot buy research results. You cannot buy answers.

If we had a billion dollars made available to find a solution to cancer, the billion dollars would be no guaranty that we would get the cure for cancer. The problem of research is to place our most competent research scientists in the best possible environment with all of the possible equipment and help they need to maximize their individual effectiveness as creative scientists.

And if you restrict, limit, and try to economize dollarwise with respect to this, this is what I call false economy.

The payoff from the product of your very best minds in research and development is so gigantic that you cannot afford to waste the dollars by being niggardly with respect to research support.

When it comes to development, however, this is where big money is spent. The money spent on pure research and basic research, trying to find the fundamental answer, is but a very small fraction of the total money spent in what is called and lumped together as research and development.

It is the development of new ideas into new instrumentation in weapons, prototypes, and so on, for testing that costs the big money.

Here is where the decision is made to spend the big money—where you need careful and wise decisions.

I have long been an advocate of what I call careful, prescientific analysis of proposed weapon systems, spending more time analyzing in detail the future possibilities, the future performance potentials, and so forth of new weapons systems, rather than going ahead and building 3 or 4 or 5 or 6 different types of competing weapon systems for test and trial.

The English have brought this type of analysis to such a fine art because they have a limited number of scientific people, limited facilities. Further, they have an economy which will not support a big, national defense effort. Consequently, the English, in the management of their research-and-development program, spend an enormous amount of analytical time making the decisions as to which particular weapon systems they will build and develop for use in their system.

And we could take a page out of the British book very successfully, in my judgment, and save ourselves a great many millions of dollars with respect to the production, in the development stage of many different types and kinds of weapons.

Furthermore, all of these decisions have to be made—decisions as to whether you are going to build particular weapons systems—in the light of the weapon capability of your potential enemy.

I think the Russians made a decision, perhaps, as early as 1950 of this kind. I believe the Russians decided to go after the intercontinental ballistic missile as a better weapon system than intercontinental bombers. The Russians have developed long-range-bomber aircraft, but I do not think they are going to build a fleet of 1,000 or 2,000 when they can build the ICBM and accomplish the same destructive effort that we can with bomber aircraft.

This was a major decision for the Russians to make. They made it, I believe, and it has proved to be a wise decision. In any event it is obvious they put an enormous effort into the development of intercontinental guided missiles as their answer to the problem of attack of this country. There can be no other purpose for such weapons.

Mr. POLAND. Would this be a part of the management procedure developed a little later in your statement—this management procedure for decision-making?

Mr. HOVDE. Yes, indeed.

Mr. POLAND. I notice you have that broken down under about 4 heads, "to avoid confusion," and 3 others. And the question I noted on that was, Must these forward steps await the completion of a study which you suggest, or can they be incorporated piecemeal in the management procedure?

Mr. HOVDE. I am not sure I quite understand your question.

Mr. POLAND. You suggest a study should be made in respect to management procedures. And then you suggest four different things which should be done—the objectives to be sought.

My question is, Must these objectives await the completion of a study or can you put them into effect now?

Mr. HOVDE. I think you have to put your very best and most competent leadership on the problem of the management structure. Put them to work and let them come up with recommendations to provide this kind of management, which will produce wise decisions and make sure that such decisions are based on the finest kind of test and analysis we can command—the most imaginative forward look.

I cannot prescribe the form of organization myself at this time.

Mr. POLAND. You do not think it can be accomplished administratively step by step?

Mr. HOVDE. I think the administrative structure should be carefully studied. Charges will have to be evolved out of our experience with the way we have managed things in the past. Improvement in the management structure will require constant and continuous study.

Mr. MCCORMACK. By management structure you mean in the Government?

Mr. HOVDE. In the Government, in the Department of Defense, and on down. I am sure that Secretary McElroy is aware of this. I do not know what he is doing. Presumably, he and his advisers are working on these very problems. I believe even the President is in-

teresting himself in this problem. At least, he made such a promise to the American people in a speech not so long ago.

Mr. McCORMACK. Will you scan over this list and see if that is a list of your advisory panel? I just happen to have that list. That will save the necessity of making inquiry otherwise.

Mr. HOVDE. This is a list—I don't know when this was printed—but we can see that Mr. Lanigan has an up-to-date complete list.

Mr. McCORMACK. This was obtained through other sources than the staff of this subcommittee. I think you better take that and check on it and see to be sure that it is. We want to be accurate.

(The following list of Army Scientific Advisory Panel members was supplied by the Department of the Army, after the hearing:)

THE ARMY SCIENTIFIC ADVISORY PANEL

* * * Will advise the Secretary of the Army, Chief of Staff, and Chief of Research and Development on all scientific and related matters of concern to the Army; from their knowledge of advanced research trends, advise of particular lines of endeavor on which emphasis should be placed; advise when research in a specific area has progressed to such a point as to permit effective application to military operations; advise on all matters which may influence the successful prosecution of an effective research and development program. * * *

Dr. Frederick L. Hovde, president, Purdue University, Lafayette, Ind., chairman
Mr. Richard S. Morse, president, National Research Corp., 70 Memorial Drive, Cambridge, Mass., vice chairman
Maj. J. D. Neumann, Office, Chief of Research and Development, Department of the Army, Washington, D. C. executive secretary
Dr. W. R. G. Baker, vice president, General Electric Co., Electronics Park, Syracuse, N. Y.
Dr. Stanhope Bayne-Jones, 3227 Reservoir Road NW., Washington, D. C.
Dr. Hendrik W. Bode, director of research, Bell Telephone Laboratories, Inc., Murray Hill, N. J.
Dr. Ralph Bown, 85 Pine Street, Maplewood, N. J.
Dr. Detlev W. Bronk, president, National Academy of Sciences, 2101 Constitution Avenue NW., Washington, D. C.
Dr. Leonard Carmichael, secretary, Smithsonian Institution, Washington, D. C.
Dr. Leonard S. Cottrell, social psychologist, the Russell Sage Foundation, New York, N. Y.
Dr. C. S. Draper, head, Department of Aero Engineering, Massachusetts Institute of Technology, Cambridge, Mass.
Dr. John R. Dunning, dean, School of Engineering, Columbia University, New York
Donald G. Fink, director of research, Philco Corp., Philadelphia, Pa.
Harvey Gaylord, president, Bell Helicopter Corp., Box 482, Fort Worth, Tex.
Dr. Lester M. Goldsmith, the Atlantic Refining Co., Post Office Box 7258, Philadelphia, Pa.
Dr. Alvin C. Graves, Los Alamos Scientific Laboratory, Los Alamos, N. Mex.
James M. Hait, executive vice president, Food Machinery & Chemical Corp., Box 760, San Jose, Calif.
Dr. Harry F. Harlow, professor of psychology, University of Wisconsin, Madison, Wis.
Dr. Robert T. Haslam, director, W. R. Grace & Co., 7 Hanover Square, New York, N. Y.
Willis M. Hawkins, assistant general manager, Lockheed Aircraft Corp., Sunnyvale, Calif.
Dr. A. G. Hill, director of research, WSEG, Room 2D 996, the Pentagon, Washington, D. C.
Dr. William A. Hunt, professor of psychology, Northwestern University, Evanston, Ill.
K. T. Keller, Room 1216, Fisher Building, Detroit, Mich.
Richard C. Kerr, 530 Park Avenue, New York, N. Y.
Dr. George E. Kimball, Arthur D. Little, Inc., 30 Memorial Drive, Cambridge, Mass.

Dr. Charles C. Lauritsen, professor of physics, California Institute of Technology, Pasadena, Calif.
Maj. Gen. Edmond H. Leavey, United States Army retired, president, International Telephone & Telegraph Corp., 67 Broad Street, New York, N. Y.
Dr. Andrew Longacre, Control Systems Laboratory, University of Illinois, Urbana, Ill.
Dr. James W. McRae, president, Sandia Corp., Albuquerque, N. Mex.
Maj. Gen. K. D. Nichols, United States Army retired, Consulting engineer, 1701 K Street NW., Washington, D. C.
Dr. A. A. Nikolsky, John C. Green Foundation, Princeton University, Princeton, N. J.
Daniel E. Noble, executive vice president, Motorola Inc., 5505 East McDowell Road, Phoenix, Ariz.
Dean W. Albert Noyes, Jr., Professor of chemistry, University of Rochester, Rochester, N. Y.
Dr. Walter J. Nungester, University of Michigan Medical School, Ann Arbor, Mich.
Dean Morrough P. O'Brien, College of Engineering, University of California, Berkeley, Calif.
Dr. W. George Parks, head, Department of chemistry, University of Rhode Island, Kingston, R. I.
Dr. Joseph M. Pettit, Electronics Research Laboratory, Stanford University, Stanford, Calif.
C. G. A. Rosen, 1510 Portola Avenue, Menlo Park, Calif.
Dr. John D. Ryder, Dean, College of Engineering, Michigan State University, East Lansing, Mich.
Dr. William Shockley, director, Shockley Semiconductor Laboratory, 391 South San Antonio Road, Mountain View, Calif.
Dr. Kenneth W. Spence, Head, Department of Psychology, University of Iowa, Iowa City, Iowa.
Dr. Edward C. Stevenson, Professor of Physics, University of Virginia, Charlottesville, Va.
Maj. Gen. L. J. Sverdrup, Reserve, president, Sverdrup & Parcel, Inc., 915 Olive Street, St. Louis, Mo.
Gordon N. Thayer, vice president, Ohio Bell Telephone Co., Cleveland, Ohio.
Dr. Robert L. Thorndike, Professor of Education, Teachers College, Columbia University, N. Y.
William C. Tinus, vice president, Bell Telephone Laboratories, Inc., Whippany, N. J.
Dr. John E. Vance, head, Department of chemistry, New York University, New York, N. Y.
Eugene L. Vidal, Avon, Conn.
Dr. Eric A. Walker, president, Pennsylvania State University, University Park, Pa.
Dr. Charles E. Waring, head, Department of chemistry, University of Connecticut, Storrs, Conn.
Dr. Ernst Weber, vice president for research, Polytechnic Institute of Brooklyn, 55 Johnson Street, Brooklyn, N. Y.
Dr. Harold C. Weber, Professor of Chemical Engineering, M. I. T., Cambridge, Mass.
William Webster, executive vice president, New England Electric System, 441 Stuart Street, Boston, Mass.
Dr. Jerone B. Wiesner, director, Research Laboratory of Electronics, M. I. T., Cambridge, Mass.
Dr. Dean E. Wooldridge, president, The Ramo-Wooldridge Corp., 5730 Arbor Vitae Street, Los Angeles, Calif.
Dr. Herbert F. York, director, UCRL-Livermore, Post Office Box 808, Livermore, Calif.
Charles H. Zimmerman, NACA, Langley Aeronautical Laboratory, Langley Field, Va.

Mr. McCORMACK. Any further questions?

Mr. LANIGAN. I noticed in the letter of October 30, the Army Scientific Advisory Panel stated that one of the principles that they thought should be followed was that there be established freedom and authority for each service to carry out research and development

necessary to discharge its obligations as delegated in its individual mission.

Is there a real need for this freedom and authority at the present time?

Mr. HOVDE. When the management puts artificial limitations on the Army in terms of weapons, to do its job; namely, to fight brush wars and fight them anywhere on the globe—artificial limitations such as range of its weapons or 5,000-pound limit on the kind of airplanes it can use, this is like telling a man who has to dig a big ditch he can only use a teaspoon to do it. That is my feeling and judgment.

This is the kind of restriction under which the Army research and development labors.

Mr. MCCORMACK. For example, the 200-mile range?

Mr. HOVDE. Exactly. If we are going to fight the Russians and they have 800- or 900-mile-range missiles to fight the war in Europe or maybe in Africa, whatever it might be, our Army must be prepared to fight at least on equal terms.

Mr. MCCORMACK. If the Army knows that instead of a thousand miles they are limited by orders to 200 miles, it would be a handicap.

Mr. HOVDE. If you ask the Army to do a specific job in the defense of the Nation either offensive or defensive in nature, then at the same time you tell them, "We are going to put some limitations on you as to the kind of weapons you can use to do your job," and then expect them to do a first-class job against the kind of enemy that it must face—this makes no sense to me.

Mr. MCCORMACK. I agree with you.

Mr. HOVDE. The Army, Navy, and Air Force in and of themselves, as I mentioned, are enormous organizations. Management is an intellectual function. The efficiency of management is always related to the size of the organization you are managing. The human mind is not capable of handling many variables. If you have a problem involving more than 3 variables, there are really very few people who can handle more than 3 variables in any thought process.

Industry finds this true. This is why big industry in our country divides its operations up into a great many small operations and gives the managers of the smaller operations a great deal of authority and autonomy for the efficiency and functioning of those units. It is true in General Motors and in General Electric and in Du Pont, all of our large, well-managed American industries.

That is why, in my judgment, the management of government itself, which is the largest of all man-made operations, is so difficult, it is almost beyond human capability.

Mr. MCCORMACK. And it will grow, too?

Mr. HOVDE. It has been growing and growing markedly in my lifetime, at any rate.

Mr. MCCORMACK. Are there any further questions?

Mr. LANIGAN. General Gavin, I believe, indicated that he had thought an appropriation of $560 million for research and development was needed for the Army to carry on its program, and that somewhat under $400 million had been appropriated.

Has the Scientific Advisory Panel considered, or you yourself considered the levels at which the Army should maintain its research and development activities?

Mr. HOVDE. The panel as a whole has never been given the problem of determining the size or magnitude of the dollar expenditures required. Our problems are primarily scientific advice with respect to how the Army can get solutions to its needs—that is, be prepared to fight under conditions of warfare in the future against all enemies. It has to provide itself with extreme mobility, it has to have enormous firepower in the hands of small, autonomous units that can protect themselves, that can move rapidly, can remain in communication, can even act independently. It has to have many different types and kinds of reconnaissance and intelligence services. It has to have many things in order to fight the kind of warfare that men foresee, and that men are preparing for, and that the enemy is prepared to fight.

The size of the research effort is dictated more, in my judgment, by the quality of the people you put on the problem than by the dollars you have, because in many of such problems it does no good—you understand I mean research—it is a different thing in development—it does no good to put more and more people on it. Satisfactory solutions are more likely to come by putting your very best minds on the problem. We have never considered, Mr. Lanigan, the actual problem of what the total dollar value should be.

All I will say is, in my personal judgment, that the division of the moneys made available for research and development, has put extreme limitations on the Army to do its job.

One of the types of limitation that I mentioned was the 5,000-pound limit on aircraft. Certainly, if the Army has to move its people fast and it has to move its equipment fast, it has to have reconnaissance, it has to have tactical air support, it has to have all kinds of air mobility. In recent years a great many new ideas have come along in the fields of airplane and helicopter design and vertical lift aircraft to meet special Army needs.

Unless the Army is permitted to develop these ideas its efficiency and capability to do its job is seriously endangered.

Mr. LANIGAN. You do not think they have that?

Mr. HOVDE. I do not believe the needs of the Army have been recognized in terms of the importance of the mission of the Army of the future, because I agree with General Gavin that the control of the land, is now more important than control of the air.

Mr. LANIGAN. I noticed in your statement, and also, in the letter there is a reference to unnecessary duplication of particularly it seems in the development area, although it is not quite clear, at least, in my reading of it, just what you have in mind as to what type of duplication is undesirable and in what field it is desirable.

Could you give us a little more information, perhaps, an illustration of that?

Mr. HOVDE. I believe that when you have problems, especially problems of the kind for which there are alternate solutions and alternate proposals, insofar as preliminary investigation is concerned and research is concerned, these preliminary different ways of doing things should be explored to the point where you have enough information to make a decision whether you will spend big money to develop a weapons system. In general we have not done enough research and spent too much on developments that have not paid off. This applies to almost all types and kinds of weapons.

Mr. McCormack. Who should make that decision?

Mr. Hovde. That decision should be made by the Department of Defense. And first it should be made within the service itself.

Our tendency has always been to do everything—the stakes are so great and our economy so strong that we wouldn't neglect anything that had some potential. This philosophy has led us to do everything instead of performing what I call preanalysis—making the finest kind of analytical judgment before you decide to spend millions and millions on a particular weapons system.

Mr. McCormack. That decisionmaking, with the authority to carry it out would be on a high level?

Mr. Hovde. Yes, it would be.

Mr. McCormack. Should it be at the defense level?

Mr. Hovde. I do not think you can go above this. I think the Department of Defense should be constituted so that it can manage defense. The only authority above it is, of course, the President.

Mr. McCormack. In other words, you think, your opinion is, that there has to be some authority under the defense level itself as distinguished from the coordinated branches?

Mr. Hovde. I think that is correct. This authority has been exercised. It has been exercised in the forms which I previously mentioned, 200-mile limit on the Army missiles and 5,000-pound limit on experimental airplanes. Who made the decision?

Mr. McCormack. If the Army knows they can go beyond 200 miles; is that right?

Mr. Hovde. They are not supposed to.

Mr. Lanigan. To get to the other point you mentioned, that is, a clarification of missions—isn't that correct, that gets to that?

Mr. Hovde. I think the present missions are based on the Key West agreements, approved after the war. A lot of water has gone over the dam in terms of our own development and in terms of Russian development since the days of the Key West decision. And I think it is about time that somebody took a look at this agreement which is a basic management directive saying who is to do what.

Mr. McCormack. That was a compromise.

Mr. Hovde. All of these things are, Mr. Chairman. There is no black and white in this world. Especially in Government.

Mr. Lanigan. You indicated this letter had been sent to Secretary Brucker and then you said that it is up to him to decide what to do with it, with his recommendations.

Has the Secretary's office consulted with the Advisory Board or dealt further with respect to implementing the suggestions?

Mr. Hovde. No, I think these are matters which are truly Department of Defense responsibilities. What Secretary Brucker can do about them, he must determine himself and whether he has the influence, the power, and the authority to have a voice in the reorganization of the Defense Department presumably is up to Mr. McElroy and the President. Those in control have the authority and responsibility.

Mr. Lanigan. One other problem that we discussed this morning, as of course, you are aware, was the problem of the withholding of funds to the research and development after they have been appropriated. I believe it was pointed out that in 1957 fiscal year, $25 million of the Army's research and development appropriation was set aside

and not made available until 1958 fiscal year. In 1958 fiscal year, there was set up a $17 million budget reserve which was set aside and not made available. And in addition, there was a cut of 10 percent in the availability of funds for research and development activity even after they were appropriated.

Later on these last two actions were rescinded, and the money was made available, but there was a gap in the program.

Do you have any comment on how that affects—that type of action—affects the Army in its work?

Mr. HOVDE. I heard what General Gavin said this morning and agree with him. It is difficult to manage such a program under such restrictions.

In my own university we have research contracts and I make arrangements with men and give them commitments for employment and salaries and jobs to do and so on, on the basis of the contracts. Then the word comes along that the money is to be cut. I am left holding the bag.

Where is research done in our society? It is done in several places—perhaps three.

At the universities, in their graduate schools, and research laboratories.

It is done in the industrial laboratories of the Nation, some 5,000 of them.

It is done in the laboratories of the Federal Government.

You cannot employ a research staff and have it work effectively and happily when you do not have long-term financing and long-term guaranties.

And besides, short-term operations are foolish per se because research is a long time investment and the payoff is always in the future. Further, it is a gamble. You can never guarantee results from any research program. Many research programs result only in telling you how not to do something, or how you cannot learn what you would like to know.

Mr. MCCORMACK. We have to realize——

Mr. HOVDE. I said earlier, you cannot buy the answers. You can invest the money in the men who have the talent to find the answers and you hope the answers will be forthcoming. The scientific method is a useful way of solving problems and producing new knowledge but many scientific investigations produce negative results.

Mr. MCCORMACK. There are bound to be some failures?

Mr. HOVDE. Yes.

Mr. MCCORMACK. We have got to expect that——

Mr. HOVDE. Yes, indeed.

Mr. MCCORMACK. In order to get successes.

Mr. HOVDE. There are a great many people working on the problem of cancer but we haven't got the cure yet.

Mr. MCCORMACK. Yes; that is true.

Mr. HOVDE. As sure as I am sitting here we will get the cure some day. When, I do not know. I know that no competent scientist—none of them—will predict.

Mr. LANIGAN. Do you think it is imperative that the Army's scientific research and development program be expanded beyond any expansion proposal which has been made public or proposed to Congress to date?

Mr. HOVDE. No; I am not particularly concerned with that. However, we must proceed at high priority with the scientific exploration of the space beyond the earth's atmosphere. Further, the only potential enemy we have in this world is making enormous progress in military science and technology. Of this we have undeniable evidence. It means that we must support our scientific and technological manpower. And we have to make sure from here on out that it is just of top quality.

Mr. LANIGAN. What can we do to get our best minds into this necessary research effort? And how can we identify those people and bring them to the fore?

Mr. HOVDE. The training of scientists, is of course, a function of our universities. There are about 100 universities in our land that maintain graduate schools. And about 50 produce about 90 percent of the graduates with doctors degrees.

Last year our output of doctors of philosophy in the field of science and engineering was of the order of 5,000. This is not enough to guarantee scientific superiority.

Science is vital to national defense—it is equally vital to the welfare of our industrial economy.

In my judgment, scientific knowledge is the only unlimited in-put into our free-enterprise system. Our free-enterprise system functions well under conditions of expansion. But it does not function very well undere static conditions. If we stop the expansion of the frontiers of knowledge we will do grievous harm to our free-enterprise economy.

Mr. MCCORMACK. Are there any further questions?

Mr. POLAND. Have you seen Chairman Dawson's bill, H. R. 10293, to establish a national scientific reserve fund?

Mr. HOVDE. Yes; I had the privilege of reading it this morning.

Mr. POLAND. Would you like to give the committee the benefit of your judgment on the bill?

Mr. HOVDE. My immediate reaction after a first reading this morning, is that if I were the Director of the National Science Foundation and had available such a reserve fund against which to supplicate for funds when break-throughs occur and important jobs develop, as they do, every month, every week of the year, it would be one of the finest administrative adjuncts that he could possibly have. Then we would not let a year and a half go by before we could exploit new scientific developments.

So I would say it would be a very, very excellent reserve fund, one, if the Science Foundation had something that was not funded and needed backing quickly it could proceed without delay.

Mr. MCCORMACK. Are there any further questions?

Mr. HOVDE. Actually, we do this in university management. We always tuck away a few reserve funds and then if something happens during the year that is critically important we have a few dollars to apply to take care of such unforeseen and unbudgeted needs.

Mr. MCCORMACK. I take it you agree pretty much with General Gavin as to the necessity of coordinated action in results within the near future that lies ahead?

Mr. HOVDE. Yes; I find myself in general agreement with General Gavin on many of these issues, since I worked closely with him for the

last 3 or 4 years. I have a very high regard for his analysis of the problems we are facing.

Mr. McCormack. We have the brains, I take it, in the country and we have the facilities?

Mr. Hovde. Well, sir, people like to carp and criticize, but I, also, like to point to the performance of our country.

I, also, like to point to the performance of our educational system, too.

If I may be allowed to speak on my professional subject, namely, education, I would say that I would not trade the American system of education for any that I have seen elsewhere, including Russia.

Despite all of the deficiencies of the American high school, it has been created to provide an educational opportunity for all American youngsters.

In our high schools we instruct over 75 percent of the age group 14 to 18. In Russia, I am told, they have a 10-year school system. In the last 3 years of that 10-year system only 33 percent of their youngsters receive instructions. Seventy percent are eliminated after 7 years of elementary instruction.

I believe that the general education program for our citizenry and our young people throughout the Nation is the first requirement of making a democratic form of government function successfully.

Throughout the towns, villages, and cities of our Nation, the American high school is one of the most important institutions in the life of our people.

We have treated our teachers through the years pretty shabbily. They have been the people that really subsidized American education at all levels. But, on the other hand, their performance is remarkably good.

This does not mean that improvements cannot nor should not be made.

We have an enormous job to do to improve the quality of our teaching, the quality of our educational experience in our secondary and high schools and in our colleges, for that matter. But this will evolve slowly as we are able to command the best people. Until we can command the best people to teach our youngsters we are not going to improve our system very much because we can't change it unless we have more and better trained teachers.

Of the total high-school enrollment, at the maximum, only 20 percent express an interest in science. This is enough. Of the 20 percent, 10 to 15 percent may go on to college to prepare for careers in science and engineering. We have enough young talent to provide all of the scientific people we need for our national development if we provide better teachers, better facilities, and higher standards of achievement.

It is utterly silly to provide 5 years of mathematics and 4 years of physics and 4 years of biological science to 75 percent of our youngsters because there is no point in trying to teach a youngster something he cannot absorb or understand. Such a program would be a waste of money and teaching effort.

The problem is to provide something better than what we now have for our best intellectual talent in all our high schools. Our best talent must be found, identified, encouraged, counseled, guided,

and directed into the channel that will produce the trained people we need.

We cannot do this by ordering people in our country. I think the Russians have a system whereby they can direct their people a little more easily than we can. But I do not want the Russian system. I think ours in the long run will be more effective.

Mr. McCormack. Are there any further questions of Dr. Hovde?

Dr. Hovde, we appreciate very much your appearing before us.

Mr. Dawson. We appreciate his contribution.

Mr. McCormack. We thank you very much. And I am happy to hear your last statement. I think it is very appropriate. I have complete confidence in this generation. Every generation has those who do things that they should not do, but the whole generation is not guilty because of what a small percentage does. I think that is what you had in mind.

Mr. Hovde. Thank you, Mr. Chairman.

Mr. McCormack. We overlook the youngsters whom we see walking along, the husband and wife with their baby carriage. And I look at them and they are representing the hearts and souls, the real strength, spiritually and otherwise of this generation and the coming generation.

When we were kids we had our tough gangs and we did not like them. On the other hand, there was an awful lot of good youngsters.

Mr. Hovde. Most of us quickly forget what we were like when we were young. You cannot expect the youngster of 16 to have a mature mind or act like a 50-year-old man with many years of experience behind him. When you expect that kind of maturity from youngsters you ask for the impossible. Even so, today's youth is healthier, better educated, and more responsible than they were 25 or 50 years ago.

Mr. McCormack. The problems confronting them are much different from the problems we had, too.

Mr. Hovde. They are different and more difficult.

Mr. McCormack. The pressures upon them are much greater.

Mr. Hovde. Correct.

Mr. McCormack. Thank you very much. We appreciate having had you here.

Mr. Hovde. Thank you. You have been very courteous.

Mr. McCormack. The subcommittee stands adjourned, subject to the call of the chair.

(Whereupon at 3 p. m., the hearing was adjourned.)

RESEARCH AND DEVELOPMENT

(Part 1—Background Testimony)

WEDNESDAY, FEBRUARY 12, 1958

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON EXECUTIVE AND
LEGISLATIVE REORGANIZATION
OF THE COMMITTEE ON GOVERNMENT OPERATIONS,
Washington, D. C.

The subcommittee met, pursuant to recess, at 3:10 p. m., in room 1501, New House Office Building, Hon. Robert E. Jones presiding.

Present: Representative Jones and Dawson.

Also present: Orville S. Poland, general counsel to the committee; James A. Lanigan, associate general counsel; William A. Young, staff consultant; and Elmer Henderson, committee counsel.

Mr. JONES. Will you please advise the Chair of the status of the witness' testimony?

Mr. LANIGAN. Dr. Turkevich was scheduled for 2:30, but the House was involved in consideration of the Yellow Tail legislation, so he has not started his statement. He is going to give us a run down on the organization for research and development in several countries.

Mr. JONES. Well, Doctor, we are delighted to have you here today and let me again apologize for the attendance, but that is the way things run up here. Sometimes we expect good attendance, but then we have rollcalls unexpectedly and that disturbs the orderly consideration of hearing witnesses, which we are always reluctant to have, but since this is an afternoon session, this is something we can expect.

It is, again let me tell you, good to have you here and you may proceed.

STATEMENT OF DR. JOHN TURKEVICH, EUGENE HIGGINS PROFESSOR OF CHEMISTRY, PRINCETON UNIVERSITY

Dr. TURKEVICH. I am very happy to be here. This is not the first time I have been before a House committee. It is always a pleasure to testify here.

I would like to present material based on my experience as a teacher of science for the last 25 years at Princeton University, where I have taught the first year chemistry, to a large number of undergraduates; also, I have taught in the graduate school. I have had experience as a research scientist doing pure research at Princeton University during last quarter of a century. At present I hold the Higgins Chair of Chemistry at the University. I have also had a certain amount of experience in Government, scientific work, working both for the Atom-

ic Energy Commission and the Air Force. I have lectured at the Army and Air War colleges. Since I am of Russian parentage and know the language very well, I have been a student of Soviet science and technology. I have written extensively on the subject and I have represented our Government in dealings with the Soviet science leaders. I know the leaders in the Soviet scientific world and have negotiated with them. I would like to present to you some of the impressions that I have on the organization of science in the Soviet Union, United Kingdom, and Canada. Before I do that I would like to put into the record some of my ideas on what role science is playing right now in world affairs because I am convinced that science and scientific education are going to be the dominant factors in our national living for the next 2 or 3 decades. It is therefore very important to be able to better organize the government scientific effort in this country.

Due to the spectacular Soviet success in launching satellites there has been given, an impression around our country that the Soviet science is very good, better than ours; that Soviet education is very good. I want to dispel that. We still have the best group of scientists in the world, the best scientific plant and the best educational scheme. On the other hand we have a considerable amount of disorganization in science and this is where I think it is very important——

Mr. JONES. Would you like to give us some idea what has contributed to that disorganization and where it was born?

Dr. TURKEVICH. I think I will be able to in the course of my testimony.

Mr. JONES. All right, fine.

Dr. TURKEVICH. What I would like to do is present to you some of my general ideas of the importance of science, how science is organized in Canada, in the United Kingdom and the Soviet Union. Then I wish to show where we fit into the figure. This is going to be my approach.

Mr. JONES. All right, you may proceed.

Dr. TURKEVICH. Science and education are nutrients essential for the industrial growth of any modern state. For industrial processes are constantly changing, making continued demands on technology, for its part, rests heavily on a widely developed scientific activity. All these in turn depend on education. We must have a general education to assure that people know how to live in the modern world. We must have a specialized education to produce operators of the manifold technological services of modern living. We must have engineering education to develop new facilities and processes, and then we must have scientific education leading by a continued study of nature to the discovery and systematization of new findings. Finally the development of man's destiny requires a favorable political, social, and cultural milieu and an education that produces the individually creative man. This last factor is very important and this is what we have and the Soviets do not have. We want a man who will make the logically unpredictable and the intuitively unexpected discoveries of science. These discoveries may radically change the industrial development of a nation, alter its technology and influence the very character of science itself.

I would like to recall to you just what happened in the Atomic Energy field.

In 1939 a group of people made the fundamental discovery and here we in 1958 are in a completely different world. Other discoveries can produce similar far-reaching effects.

Mr. JONES. Let me ask you this question at that point. My recollection is that the atomic research accomplishments were made by a single organization. Recently you heard certain people in the military say the only way you can make scientific advancement is through competitive effort. Therefore each branch of the service should have this activity competitive with the other military forces and that is the only way that you are going to make scientific accomplishments is to have competition between the branches of the armed services, and that is the way we are going to accomplish this.

Dr. TURKEVICH. I don't subscribe to that point of view and I will amplify on it later. Science and education of any country have both international and national characteristics. In its international aspect, modern science is the result of contributions of scholars of many countries.

Again I would like to point out that there is an impression in this country that Americans do not produce good scientists. This is not so. You don't have to be a foreigner to be a good scientist. We can judge this on the basis of the Nobel prizes that have been awarded in recent years. America has been very strong there. It has been people who have been educated in the United States, in our colleges and secondary schools that have attained these awards and consequently one should not sell short American education and American scientists.

In its international aspect, modern science is the result of contributions of scholars of many countries. The modern nuclear age was ushered into the 20th century by the work of the Germans, French, and the Americans. This international aspect of science is apparent also in scientific and technological education. In general the facts of science are invariant toward national transformations. Passage over political boundaries and through ideological curtains alters only the printed word, but not the content of scientific treatises and the text books, the organization of scientific facts and theories, and the logical thinking that scientific education entails. The international aspect of science is further emphasized by the freedom of exchange, and communication of scientific ideas and discoveries. Ever since civilized man freed himself from the mumbo-jumbo of the witch doctors and the secret jargon of the alchemical adepts, scientists have freely communicated their work in private letters and journals, attended international meetings, and studied in foreign lands. International cooperation in science guarantees not only a minimum of duplication but assures a cross fertilization of ideas and helpful criticism.

This is a very important aspect for the development of science, an aspect that the Soviets violated under Stalin. Recently they have paid proper respect to it. Their strength arises from their ability to exploit efficiently the discoveries of other countries.

I would like at this point to interject an experience I had at Geneva, in the summer of 1955, where I was adviser to the American delegation to the Conference on the Peaceful Uses of Atomic Energy. Because of my language ability and my background I had dealings with the Soviet delegation and I served as liaison officer for the American

delegation. I got to know quite a number of the Soviet people there. I gave my scientific paper next to the last day and a number of the Soviet delegates were present. One of them, a Minister of Cultural Relations with Foreign Countries, came up to me and congratulated me on the paper. I thanked him and said it was very pleasant to have competition with the Soviet Union, not in military and economic things, but in science, I used the Russian word "concurenzia" for competition. The Soviet delegate said:

> Don't use that word. It has a very bad connotation in Moscow. It means getting ahead by crushing the other person into the ground. We have a better term called soreunovanye. It means getting ahead by climbing on the other man's shoulders.

It is my feeling that this is the technique that the Soviets are using right now in their idea of coexistence. They are not out to crush us in science and in other things. They are out to build on us. This is why free exchange of scientific information is so very important to them because they can utilize for their use our basic studies. They are not contributing too much to the basic science of atomic energy, but because of their planning, because of their efficient gathering of information, they know when to go into the application of basic information and use it for political and military purposes.

Now this is part of the general plan that scientists use for developing science. The Soviets are using it for their own political and military purposes.

Mr. JONES. Are you saying there, Doctor, that—well, let's call it the political sciences are just as important as their scientific accomplishments?

Dr. TURKEVICH. No. What I am trying to convey is that they are better organized to exploit scientific discoveries for political purposes than we are.

Mr. JONES. Well, now, you don't say the scientists are making these political advancements with their discoveries; it is a political society that they have trained, as well as the fellow who works down in some laboratory?

Dr. TURKEVICH. That is right.

Mr. JONES. Now it brings me to the next question. Don't you think that the political sciences are just as important as the technological advancements that we might make in the laboratory of developing the engineer and all the other technicians to get in this rush for scientific accomplishments?

Dr. TURKEVICH. Yes.

Mr. JONES. What is it going to amount to if you get all these things if you are not going to keep your political fences well mended and your political know-how, which are based on scientific approach, study, political acuemens that people are able to possess? If you are racing with one hand with scientific discoveries and then you are back in the rural section with your political thinking——

Dr. TURKEVICH. Well, this, of course, is one of the sad situations in the Soviet Union in that political and technological maturity is much easier to obtain than muturity in politics and the social relations.

Mr. JONES. Are you seeking political sympathy for what you are trying to do in the scientific world?

Dr. TURKEVICH. I don't think I am quite getting you, sir.

Mr. JONES. Well, you say, as I understand you, there is a parallel advancement, the political advancement, the scientific advancements are wed in the Soviet country in Moscow; therefore, when you make scientific accomplishments, they are making political advancements that are correlated with that.

Dr. TURKEVICH. That is right, sir.

Mr. JONES. Now in this country scientific advancement is not made and it is not the timing of it—it is not coordinated exactly. Take today, for instance, everybody is jumping up and down and saying boy, all we need to beat this thing is get a lot of scientific colleges and the reason we are behind is nothing the dollar won't cure. Give us all the money we can get to take these young geniuses out of high school and college and we will raise them and they will make scientific discoveries that will just embarrass every Russian that ever lived.

Now what are we going to do about the general scientists, the political scientists, because we are not going to advance in a world such as we have today unless we make political accomplishments.

Dr. TURKEVICH. Certainly. I would subscribe to this point of view. After all, I do teach in a university that is wedded to that principle and that for the development of leadership in the country and education you must have, in addition to a scientific education, a very strong political education and an education in the humanities.

I have taught for 3 years in the Woodrow Wilson School of Public and International Affairs and I subscribe to that point of view. But what I was trying to point out in connection with the Soviet system was that they are using their scientific discoveries as a vehicle for their sordid political means and aims, that their politics are certainly very crude, immature type of a politic, but they are using science for their purposes very effectively. This is the point I want to make.

Mr. POLAND. Mr. Turkevich, in elucidation of the chairman's question, in just one word or two would you be willing to tell how you correlate physical science and political science at the Woodrow Wilson School?

Dr. TURKEVICH. I had inaugurated 3 years ago an unusual seminar in relation to government and science. We take the top 15 boys who are not scientists, who are going into government, law, business, international affairs. We have a seminar on the relation between government and science. We meet once a week and these boys work up separate subjects on the relation of government and science.

For instance, we have a session on the role of the Joint Congressional Committee on Atomic Energy; on the organization of science in the military; we study the organization of science in various countries, the organization of science in industry, where does the Government fit into that.

This is an attempt to give the boys who are going through liberal arts and political science some idea of the impact of science, to get them to appreciate the importance of proper organization of science in government.

At the same time I will be quite frank with you and state that this is how I keep up with developments in the field of government and science because these students do research work for me. Some of the material I am going to present today is based on papers and

discussions that we had in these seminars at the Woodrow Wilson School of Public and International Affairs.

We also get people from Washington and from foreign governments to come and talk to these boys. We should have more such courses in government and science not only for future politicians but also for our scientists since many of my scientific colleagues are very naive about the problems of science and government. Their attitude is for more money, more men, more science, as you expressed previously. The problem is not as simple as all that.

Mr. JONES. Well, I am just reminded of how impolitic scientific advancements can make us. You will recall that when we had the scientific advantage of all the countries of the world, we had a program of massive retaliation. Do you remember that?

Dr. TURKEVICH. Yes; that is right.

Mr. JONES. Do you know how much that arrested and put in abeyance the zeal of the Soviets for world conquest? Do you think that it stopped it for one minute, impeded its progress?

Dr. TURKEVICH. No.

Mr. JONES. Well, isn't that a demonstration of how these scientific advancements can fail to be used to our advantage instead of making those kind of programs something that is going to deter the best interests of world security?

Go ahead.

Dr. TURKEVICH. Finally it is a principle recognized in the West that science brooks no interference, political or ideological, in its search for truth. The scientist holds that scientific truths are based on experiments, that valid experiments can be reproduced in any country irrespective of nationality, race, or ideological outlook; and that dogmatic deductions from religious belief, social-economic ideology, or from neat philosophical formulations have no place, as such, in the structure of scientific knowledge.

These basic concepts of science were denied in the Soviet Union under Stalin. Soviet science during that period suffered. Now with the Khrushchev group in power, many of the bad features of science in the Soviet Union have been eliminated. Whereas under Stalin science was a compartment of Marxist philosophy, now science seems to stand on its own feet. This has given Soviet science a tremendous leadership in the Soviet community. This is why Soviet science under Khrushchev is far more dangerous than Soviet science under Stalin.

Science in any given country has also its national characteristics. Through his knowledge and skills a scientist discharges his primary obligation—the defense of his country. Through their inventiveness and perseverance, scientists and engineers are bolstering the economic strength of their native land, guaranteeing an ever-increasing standard of living.

All these factors contribute to making the organization of science in one country different from the organization of science in another country. This is why in examining how science should be organized in this country to help both our national defense and our economic well-being, it is very important to keep in mind what the other countries have done. For other countries have also thought about how science should be best organized. It also should be kept in mind that you just can't carry over the Soviet practice or the British practice

or the Canadian practice directly to the United States. There are certain features that are good about them; there are certain features that are bad. Other features are local to the situation in a given country.

Canada is the first example I want to present to you of how science is organized. Canada has an outlook very similar to our outlook. It is a smaller country and in some ways a more sober country in its approach to problems of government and science.

Research in Canada is carried out by government, the universities, and industry. Government research is both in the military and civilian areas. The top authority in the military area is the Defense Research Board, established in 1947, to correlate the scientific requirements of the armed forces with the research activities of the civilian groups.

The objectives of this organization, largest in Canada, are the following: (1) To use existing Canadian research and development facilities to meet the needs of the armed forces, (2) to maintain close collaboration with scientific and technological activity in the United Kingdom and the United States, and (3) to promote standardization of components used in industry. In particular, it carries out Arctic research, cooperates with the United Kingdom Australian nuclear weapons trials at Woomera, and works with the United Kingdom Ministry of Supply on new aircraft telephoning system. It takes part in the work of the International Geophysical Year.

The Board is composed of 14 civilian members. It is a civilian organization, although it is in charge of the military research.

Mr. LANIGAN. Is it in the Defense Department?

Dr. TURKEVICH. Yes, sir. It is composed of a chairman, a vice chairman, 6 ex officio members and 6 scientists, representative of universities and industry. The chairman and vice chairman are permanent salaried members of the Board.

The chairman is appointed by the Governor-General in Council. He has the status of a Chief of Staff and as such is a member of the Chiefs of Staff Committee. He sits with the military on an equal basis; liaison is through the top, not down the line.

In no other country that I know of, do the civilians control completely the science of the Military Establishment. This is a very, very unusual feature and represents the extreme on the organization of science for defense purposes.

Mr. JONES. Doctor, let me ask you this: Are you familiar with the new organization Advance Research Projects Agency established in the Department of Defense?

Dr. TURKEVICH. I know, roughly, from the newspapers what it is.

Mr. JONES. Do you think it would compare with the agency in the Canadian Department of Defense?

Dr. TURKEVICH. Oh, no, this is nothing like it. This would mean if we were going to do the same thing in the United States as in Canada we would have all the research carried out by the various armed forces—Navy, Air Force, Army—all under one group that was civilian, that the chief of all of the scientific work would be a civilian, and that he would sit with the Joint Chiefs of Staff on an equal basis with the Army, Navy, and Air Force.

Mr. JONES. Off the record.

(Discussion off the record.)

Mr. POLAND. It is true, isn't it, that the Defense Research Board is a coordinated service in the Defense Department in Canada?

Dr. TURKEVICH. That is right, all scientific work is under their hands. The military do not control the research and development.

Mr. POLAND. It is not merely a committee of civilians acting for the military, but it has coordinate powers and duties in the Department of Defense?

Dr. TURKEVICH. That is right. For instance, the chairman appointed by the Governor General and Council has various financial and administrative powers of a deputy minister and he reports directly to the Minister of National Defense. The Defense Board Research Board has a headquarters staff, advisory committees and field research stations and 11 permanent laboratories. The value of the physical assets of the board is 30 billion Canadian dollars.

Mr. LANIGAN. Does the Atomic Energy Commission perform a similar function in this country, so far as nuclear research is concerned?

Dr. TURKEVICH. I would say so; yes. There is an analogy in this respect in the Atomic Energy Commission in that military personnel assigned to the Commission are subsidiary to some civilian members of the Commission.

Mr. LANIGAN. In that one field of science?

Dr. TURKEVICH. In that one field.

Now the value, as I say, of the physical assets of the board is 30 million Canadian dollars.

Mr. JONES. Is that the activity or administrative cost of it?

Dr. TURKEVICH. I am sorry; I made a mistake. That should be 30 billion Canadian dollars.

Civilian government research is carried out in Canada under the sponsorship of the National Research Council, the Federal Departments of Agriculture, of Mines and Technical Surveys, of Resources, of Development, of Fisheries, the Board of Grain Commissioners, the Dominion observatories and by the Provincian Government.

The National Research Council or, officially, the Honorary Council for Scientific and Industrial Research was founded in 1916 to encourage and coordinate scientific research by the central government. The Council's scientific and engineering activities are organized in 9 divisions and 2 regional laboratories, each with its own director. The divisions are applied biology, pure chemistry, applied chemistry, physics, building research, radio and electrical engineering, mechanical engineering (aeronautics and hydraulics), medical research, and information services.

The central laboratories at Ottawa are located at the National Research Building and in the building devoted to aerodynamics, engines, gas and oil, hydraulics, structures, and woodworking, engineering, and to low temperature research. The laboratories located outside of Ottawa are the Prairie Regional Laboratory at University of Saskatchewan; Maritime Regional Laboratory at Halifax, Nova Scotia; flight research section at Arnprior, Ontario; at radar station at Scarboro, Ontario. Most of the Council's funds come from annual parliamentary appropriation, supplemented by funds from industry and government for special investigations, fees for various services and income from a trust fund.

Research in argiculture was the first to receive government support and today more money is spent on this branch of research than any other.

The Federal Department of Agriculture carries out research and experimentation through its science service and its experimental farms service. Most of the nine provincial governments also have organizations for the study of problems peculiar to their own areas. The science service works on the solution of practical problems of agriculture such as animal pathology; bacteriology and dairy research; food microbiology; soil problems; fertilizers, entomology, and plant protection.

The experimental farms service studies livestock breeding; nutrition; dairying; development of cereals, grasses, legumes, forage plants, fruits and vegetables; the study of seeds, fertilizers, plant diseases, and insect pests.

Mr. LANIGAN. Is the agriculture research under the National Research Council?

Dr. TURKEVICH. No; that is a separate function. Research for mining industry is carried out by the Geological Survey and by the Department of Mines and Technical Surveys with its Mines Branch, Surveys and Mapping Branch and the Dominion Observatory Branch.

Research in forestry is conducted by the Federal Department of Resources and Development, and again I list what they do and I would like to make it a part of the record.

As previously mentioned, research in forestry and forest products is conducted by the Federal Department of Resources and Development and in addition by the several provincial governments, the Pulp and Paper Research Institute of Canada, four universities with facilities in forestry and by a number of large industrial companies.

Research in fisheries is directed by the Fisheries Research Board appointed by the Minister of Fisheries and financed from Federal Government funds. The provincial governments of Ontario, Saskatchewan, Alberta, and British Columbia cooperate extensively in fisheries research. The board operates four biological stations at St. Johns, Newfoundland; St. Andrews, New Brunswick; Winnipeg; Nanaimo, British Columbia; and three technological stations at Halifax; Grand River, Quebec; and Vancouver, British Columbia.

Mr. JONES. Doctor, let me ask you this: Do you have a prepared statement?

Dr. TURKEVICH. Yes, sir.

Mr. JONES. Without objection, the prepared statement will be made a part of the record.

(The statement reads as follows:)

STATEMENT OF DR. JOHN TURKEVICH, EUGENE HIGGINS PROFESSOR OF CHEMISTRY, PRINCETON UNIVERSITY

Science and education are nutrients essential for the industrial growth of any modern state. For industrial processes are constantly changing, making continued demands on technology. Technology, for its part, rests heavily on a widely developed scientific activity. All these in turn depend on education. We must have a general education to assure that people know how to live in the modern world; we must have specialized education to produce operators of the manifold technological services of modern living; we must have engineering education to develop new facilities and processes; and then we must have a scientific education leading by a continued study of nature to the discovery and

systematization of new findings. Finally the development of man's destiny requires a favorable political, social, and cultural milieu and an education that produces the individually creative man—the man who will make the logically unpredictable and the intuitively unexpected discoveries of science. For these may radically change the industrial development of a nation, alter its technology and influence the very character of science itself.

The science and education of any country have both international and national characteristics. In its international aspect, modern science is the result of contributions of scholars of many countries. The modern nuclear age was ushered into the 20th century by the work of the Germans, Planck, Einstein, Heisenverg, and Hahn; the French, Becquerel, the Curies, Joliot; the Dane, Bohr; and the Americans Compton, Lawrence, Urey, and Rabi. The periodic table of elements by the Russian, Mendelyeev, though enunciated in the middle of the 19th century, was a necessary link in the chain of discoveries and theories that lead to the nuclear age. This international aspect of science is apparent also in scientific and technological education. In general the facts of science are invariant toward national transformations. Passage over political boundaries and through ideological curtains alters only the printed word but not the content of scientific treatises and textbooks, the organization of scientific facts and theories, and the logical thinking that scientific education entails. The international aspect of science is further emphasized by the freedom of exchange, which is very important, and communication of scientific ideas and discoveries. Ever since civilized man freed himself from the mumbo-jumbo of the witch doctors and the secret jargon of the alchemical adepts, scientists have freely communicated their work in private letters and journals, attended international meetings and studied in foreign lands.

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On the other hand, the science of a given country has its national characteristics. Through his knowledge and skills a scientist discharges his primary obligation—the defense of his country. Through their inventiveness and perseverance, scientists, and engineers are bolstering the economic strength of their native land—guaranteeing an ever-increasing standard of living.

Home environment, differing from country to country imprints a national character on the child before he undergoes further molding in the educational system of his country. The primary school, the secondary school, and universities not only bear in their structure and spirit the character of their country, they also serve to preserve it. However, in countries with gross political economic and social injustice, the universities are also foci of ferment. Youth—full of enthusiasm, energy and idealism—often leavens national uprisings.

Science and education are essential elements of a national life. As such, in common with other national institutions, they have a tradition, organizations, budget, capital goods, record of accomplishment, personalities, training of personnel, and interaction with other groups of society. These various components have a strong national coloring difference from one county to aonther. They give character to scientific activity and education and permit us to talk of American, British, or Soviet science.

CANADA

Research in Canada is carried out by Government, the universities, and industry. Government research is both in the military and civilian areas. The top authority in the military area is the Defense Research Board established in 1947 to correlate the scientific requirements of the Armed Forces with the research activities of the civilian groups. The objectives of this organization, largest in Canada, are the following: (1) To use existing Canadian research and development facilities to meet the needs of the Armed Forces; (2) to maintain close collaboration with scientific and technological activity in the United Kingdom and the United States; (3) to promote standardization of components used in industry. In particular it carried out Arctic research, cooperates in the United Kingdom-Australian nuclear weapons trials at Woomera and works with the

United Kingdom Ministry of Supply on new aircraft telephoning system. It takes part in the work of the International Geophysical Year. The board is composed of 14 civilian members: a chairman, a vice chairman, 6 ex officio members, and 6 scientists representative of universities and industry. The chairman and the vice chairman are permanent salaried members of the board. The chairman is appointed by the Governor-General in Council. He has the status of a chief of staff and as such is a member of the chiefs of staff committee. He has many of the financial and administrative powers of a deputy minister and he reports directly to the Minister of National Defense. The Defense Board Research Board has a headquarters staff, advisory committees, field research stations, and 11 permanent laboratories. The value of the physical assets of the Board is 30 billion Canadian dollars.

Civilian government research is carried out in Canada under the sponsorship of the National Research Council, the Federal Departments of Agriculture, of Mines and Technical Surveys, of Resources, of Development, of Fisheries, the Board of Grain Commissioners, the Dominion observatories and by the provincial governments.

The National Research Council (NRC) or officially the Honorary Council for Scientific and Industrial Research in Canada, was founded in 1916 to encourage and coordinate scientific research by the central government. The Council's scientific and engineering activities are organized in 9 divisions and 2 regional laboratories each with its own director. The divisions are those of physics, pure and applied chemistry, applied biology, building research, radio and electrical engineering, mechanical engineering (aeronautics and hydraulics), medical research (having no laboratories but granting aid to research in medical schools), and information services (library, three scientific liaison offices at Ottawa, Washington, London). The central laboratories at Ottawa are located at the National Research Building (1932) and in the building devoted to aerodynamics, engines, gas and oil, hydraulics, structures and woodworking, engineering, and to low-temperature research. The laboratories located outside of Ottawa are the Prairie Regional Laboratory at Saskatoon, Saskatchewan; the Marine Laboratory at Halifax, Nova Scotia; flight research section at Arnprior, Ontario; at radar station at Scarboro, Ontario. Most of the Council's funds come from annual Parliamentary appropriation, supplemented by funds from industry and Government for special investigations, fees for various services, and income from a trust fund.

Research in agriculture was the first to receive Government support and today more money is spent on this branch of research than on any other. The Federal Department of Agriculture carries out research and experimentation through the Science Service and its Experimental Farms Service. The Science Service is directed toward the solution of practical problems of agriculture at central laboratories at Ottowa and at branch laboratories scattered throughout Canada. The Experimental Farms Service consists of a central experimental farm at Ottawa, branch stations in the more important agricultural districts of Canada and substations placed in localities where special problems are studied.

Research for mining industry is carried out by the Geological Survey and by the Department of Mines and Technical Surveys with its Mines Branch, Surveys and Mapping Branch, and the Dominion Observatory Branch.

Research in forestry is conducted by the Federal Department of Resources and Development, several Provincial governments, the Pulp and Paper Research Institute of Canada, four universities and by a number of larger industrial companies.

Fisheries research is directed by a 15 membered Fisheries Research Board. Its seven main scientific stations are financed entirely by Federal Government funds.

Many of the Provinces of Canada (Ontario, British Columbia, Alberta, Nova Scotia, Saskatchewan) have research organizations supported in whole or in part by central Government funds. These provide research facilities for the benefit of provincial interests and supply scientific information for utilization in industrial processes.

The Canadian Patents and Development, Ltd., a Crown company, subsidiary to the National Research Council, makes available to industry by means of licensing arrangements the inventions and processes developed by scientific workers of the National Research Council, Canadian Government departments and universities.

Atomic energy control in Canada is vested in the Atomic Energy of Canada, Ltd., a Crown colony formed by act of Parliament to hold the stock of two other companies, the Eldorado Mining & Refining, Ltd. and the Nuclear Research, Ltd.

The Eldorado Mining & Refining Co. Ltd., buys all uranium ores and concentrates produced by private companies in Canada. The Nuclear Research, Ltd., controls Canada's atomic energy establishment, located on the Ottawa River, 130 miles from Ottawa at Chalk River. This research establishment is engaged in development of economic atomic power, fundamental research, operation of nuclear reactors and the separation of nuclear fuels, and the production of radioactive isotopes.

Education is compulsory in Canada from the age of 6 to 14 and in some Provinces to the age of 16. In 1953 there were 31,231 elementary and secondary schools with 2,705,195 students. The population of Canada is 16.3 million. In 1955 there were 32 universities and university colleges with 62,900 students. The most important universities are Toronto (established in 1827 with 11,118 students), Lavalle (founded in 1852 with 15,000 students) and McGill (founded in 1821 with 6,918 students). There is 1 student per 259 of the population of the country. There are also 208 specialized colleges and professional schools and 39 junior colleges.

UNITED KINGDOM

Research in the United Kingdom in the military field is the responsibility of the Minister of Defence, in the civilian field of the Lord President of the Council, and in the field of atomic energy of the Prime Minister. There are two important advisory committees—the Defence Research Policy Committee and the Advisory Council for Scientific Policy.

Defense research is the concern of the Admiralty, the War Office, the Air Ministry, the Ministry of Defence, and the Ministry of Supply. The top advisory body is the Defence Research Policy Committee (DRPC) which is located physically in the Ministry of Defence with its Chairman, Sir. John Cockcroft, serving as the scientific adviser to the Minister of Defence. Although the main function of the Defense Research Policy Committee is advisory, its assumes some executive functions because of the fact that part of the committee consists of the chief research and development executives of the several military branches. The composition of the committee is

The Third Sea Lord
Deputy Chief of Naval Staff
Deputy Controller (Research and Development) Admiralty.
Chief, Royal Naval Scientific Service
Deputy Chief of the Imperial General Staff
Scientific Adviser to the Army Council
Vice Chief of the Air Staff
Scientific Adviser to the Air Ministry
Three Controllers of Supplies, Ministry of Supply
Chief Scientist, Ministry of Supply
The Secretary of the Department of Scientific and Industrial Research

The premises of the Defence Research Policy Committee were stated in the Command Paper 6923 to be as follows:

"The problem here is to secure the continued and complete integration of military and scientific thought at all levels and to see that, in planning defence research as whole, account be taken of the scientific effort of the country in other fields in order that our resources may be effectively and economically used. For this purpose there shall be a Committee on Defence Research and Policy, consisting of those responsible both for the operational and the scientific angle, for research and development in the service departments and the Ministry of Supply. This will advise, on operational questions, the chiefs of staff and on, wider aspects, the Defence Committee. Its Chairman will be a scientist of high standing, appointed for the purpose for a period of years. He will exercise his functions under the authority of the Minister of Defence with whom will rest the responsibility for the framing of general policy to govern research and development."

The committee is thus responsible for the keeping under review of the whole field of defence research and development. It evaluates and compares the research programs of the various Government agencies from the point of view of their general usefulness to the defence effort, assigns priorities to specific problems and checks on the best use of available resources of scientific manpower, materiel and money.

Only the Admiralty and the Ministry of Supply actually engage in research and development and have their own establishments for this purpose. The Ministry of Supply (Defence) carries out the research and development of the War

Office as formulated by the scientific advisers of the War Office. The Ministry of Supply (Air) carries out similar developments for the Air Ministry.

Civilian research is under the responsibility of the Lord President of the Council who formulates and executes the Government scientific policy and is the Minister responsible to Parliament for civilian government research. He is advised in the discharge of these duties by four committees: Privy Council Committee for Scientific and Industrial Research, Privy Council Committee for Medical Research, Privy Council Committee for Agricultural Research, and Advisory Council on Scientific Policy. The first three constitutional committees are advisory at high level and are composed primarily of nonscientists who advise the Ministers of the Crown and Privy Counselors and Lord President on political and economic aspects of research. These committees meet once or twice a year. Scientific representation is insured by the presence on these Privy Council committees of the secretaries of the appropriate Research Council: Council for Scientific and Industrial Research, Medical Research Council, Agricultural Research Council.

The Advisory Council on Scientific Policy (ACSP) is composed of 15 members—12 eminent scientists from universities, industry, and government and 3 senior government administrators. They are appointed by the Lord President. The Advisory Council on Scientific Policy is given responsibility for surveying the whole of the civilian field of scientific policy and is concerned in particular with the following subjects:

(1) It maintains a continuous review of the current and prospective position in regard to the supply of, and demand for, qualified scientists. It assesses from time to time the priority which the main types of demand should have on the available supply of scientific manpower. It collaborates with the Technical Personnel Committee of the Ministry of Labor.

(2) It advises generally on the organization of civil government scientific research and on the broad allocation of present and future resources.

(3) It brings to the notice of the Lord President those spheres of research where it is felt the national effort is inadequate.

(4) It advises the Lord President on the maintenance of scientific information services.

(5) It advises on the maintenance of scientific relations with other nations. In this matter it works with the Defense Research Policy Committee.

The Advisory Council on Scientific Policy is assisted by a number of subcommittees:

Committee on Scientific Manpower
Atomic Energy Committee
Scientific Library and Technical Information Committee
Committee on Overseas Scientific Relationships
Committee on Industrial Productivity
Radioactive Substances Committee
Committee on Toxic Substances in Consumer Goods
Natural Resources Committee

Dr. TURKEVICH. The Canadian Patents and Development, Ltd.—this is a very interesting organization—a subsidiary of the National Research Council, makes available to industry by means of licensing arrangements the inventions and processes developed by scientific workers of the National Research Council, Canadian Government departments, and universities.

This is a means by which the inventions made in Government laboratories are put on a licensing basis. We have no coordinated way of doing this in our country. Every Government scientific organization has its own patent divisions and its own methods of letting business take advantage of the discoveries made in Government laboratories without jeopardizing the Government interest and the people's interest in the discovery.

There is an organization similar to this in Great Britain, whereby research is carried out and discoveries made in Government laboratories are available for the industrial life of the country.

This is a very delicate point, but it has to be taken care of in any democracy.

Mr. POLAND. Would that prevent industries getting free rides on the industrial development of Government discoveries?

Dr. TURKEVICH. Correct, sir.

Mr. POLAND. Which they get in this country now.

Dr. TURKEVICH. Not always, but the procedures are haphazard in this country. This may be due to the fact that Canada and Great Britain are much smaller countries and procedures are easier to establish. We have this problem coming in the big development of the atomic energy field.

Mr. JONES. Doctor, those licenses of the Government are protected by the use of the patent?

Dr. TURKEVICH. That is right.

Mr. JONES. So there is no risk that the Federal Government will lose its investment on their scientific accomplishment that results in new patents?

Dr. TURKEVICH. That is correct, sir.

Mr. JONES. And the Federal Government is a part of—the patentee gets a right to use the patent?

Dr. TURKEVICH. Right. The atomic energy control in Canada is vested in the Atomic Energy of Canada, Ltd., a Crown colony formed by act of Parliament to hold the stock of two other companies, the Eldorado Mining & Refining, Ltd., and the Nuclear Research, Ltd. In almost all countries the atomic energy is put off as a separate organization. One has under government control a military division for research and a civilian research and the atomic energy.

The Eldorado Mining & Refining Co. buys all the uranium ores and concentrates produced by private companies in Canada. The Nuclear Research, Ltd., controls Canada's atomic energy establishment, located on the Ottawa River, 130 miles from Ottawa, at Chalk River. It is engaged in development of economic atomic power, fundamental research, operation of nuclear reactors and the separation of nuclear fuels, and the production of radioactive isotopes.

In Canada a Crown company; in the United States a Commission; in Great Britain a Government-controlled agency have the responsibility for development of atomic energy.

Education is a very important component of scientific power. As in all countries that we are going to talk about, education is compulsory in Canada from 6 to 14 and in some provinces to the age of 16. There were 32 universities and university colleges with 62,900 students. This is to be compared with Great Britain, where there are only 22 universities, and in the United States, where there are close to 1,500.

The general level of education, of higher education, is more extensive in Canada than it is in Great Britain. In conclusion I would like to call your attention to a very interesting organization of science in Canada, dominated by civilians. This may be due to the fact that the military have never been strong in Canada; their Army is a voluntary Army. Consequently the civilians play a bigger role in the whole scientific establishment of the military department.

Now let's consider the situation in the United Kingdom. Research in the United Kingdom in the military field is the responsibility of the Minister of Defense, in the civilian field of the Lord President of the Council, and in the field of atomic energy of the Prime Minister. There are two important advisory committees—the Defense Research Policy Committee and the Advisory Council for Scientific Policy.

Defense research is the concern of the Admirality, the War Office, the Air Ministry, the Ministry of Defense, and the Ministry of Supply. The top advisory body is the Defense Research Policy Committee. This is located physically in the Ministry of Defense with its Chairman, Sir John Cockcroft, serving as the scientific adviser to the Minister of Defense. Although the main function of the Defense Research Policy Committee is advisory, it assumes some executive functions because of the fact that part of the committee consists of the chief research and development executives of the several military branches. The composition of the commitee is:

The Third Sea Lord
Deputy Chief of the Naval Staff
Deputy Controller (Research and Development) Admirality
Chief, Royal Naval Scientific Service
Deputy Chief of the Imperial General Staff
Scientific adviser to the Army Council
Vice Chief of the Air Staff
Scientific advisor to the Air Ministry
Three Controllers of Supplies, Ministry of Supply
Chief Scientist, Ministry of Supply
The Secretary of the Department of Scientific and Industrial Research.

The premises of the Defense Research Policy Committee were stated in the Command Paper 6923 as follows:

> The problem here is to secure the continued and complete integration of military and scientific thought at all levels and to see that, in planning defense research as whole, account be taken of the scientific effort of the country in other fields in order that our resources may be effectively and economically used. For this purpose there shall be a Committee on Defense Research and Policy, consisting of those responsible both for the operational and the scientific angle, for research and development in the service departments and the Ministry of Supply. This will advise, on operational questions, the Chiefs of Staff and on, wider aspects, the Defense Committee. Its chairman will be a scientist of high standing, appointed for the purpose for a period of years. He will exercise his functions under the authority of the Minister of Defense with whom will rest the responsibility for the framing of general policy to govern research and development.

The Committee is thus responsible for the keeping under review of the whole field of defense research and development. It evaluates and compares the research programs of the various government agencies from the point of view of their general usefulness to the defense efforts, assigns priorities to specific problems and checks on the best use of available resources of scientific manpower and money. As we shall see when we discuss the assignment of moneys to scientific research in Great Britain, it decides whether one particular department develops one particular type of research program or another one does. The Defense Research Policy Committee coordinates the whole research and development activity in the military area.

Mr. LANIGAN. Is this committee advisory or does it actually make decisions which are carried out?

Dr. TURKEVICH. Well, the situation is typical of the British way of doing things. On paper the function is advisory. In practice its advice is crucial since it advises on the formulation of the budget, in the determination of priorities of research and development in the budget.

Mr. LANIGAN. That is really a very important function.

Dr. TURKEVICH. Certainly. More of this will come out later. What I would like to point out is that the British have a highly sophisticated system of organization of science and in many ways a very effective one.

Only the Admiralty and the Ministry of Supply actually engage in research and development and have their own establishments for this purpose. The Ministry of Supply (Defense) carries out the research and development for the War Office as formulated by the scientific advisers of the War Office. The Ministry of Supply (AIR) carries out similar developments for the Air Ministry.

Mr. LANIGAN. When you say "Ministry of Supply (Air)," you mean a division for air in the Ministry of Supply?

Dr. TURKEVICH. Yes; it is a separate group.

Civilian research is under the responsibility of the Lord President of the Council, who formulates and executes the Government scientific policy and is the Minister responsible to Parliament for civilian government research. He is advised in the discharge of these duties by four committees: Privy Council Committee for Scientific and Industrial Research, Privy Council Committee for Medical Research, Privy Council Committee for Agricultural Research, and the Advisory Council on Scientific Policy. The first three constitutional committees are advisory at high level and are composed primarily of nonscientists who advise the Lord President on political and economic aspects of research. These committees meet once or twice a year. Scientific representation is insured by the presence on these Privy Council Committees of the Secretaries of the appropriate Research Councils: Council for Scientific and Industrial Research, Medical Research Council, Agricultural Research Council.

The important committee for civilian research is the Advisory Council on Scientific Policy. It is composed of 15 members, 12 eminent scientists from universities, industry and government and 3 senior government administrators. They are appointed by the Lord President. The Advisory Council on Scientific Policy is given responsibility for surveying the whole of the civilian field of scientific policy and is concerned in particular with the following subjects:

1. It maintains a continuous review of the current and prospective position in regard to the supply of and demand for qualified scientists. It assesses from time to time the priority which the main types of demand should have on the available supply of scientific manpower. It collaborates with the Technical Personnel Committee of the Ministry of Labor.

2. It advises generally on the organization of civil government scientific research and on the broad allocation of present and future resources.

3. It brings to the notice of the Lord President those spheres of research where it is felt the national effort is inadequate.

4. It advises the Lord President on the maintenance of scientific information services.

5. It advises on the maintenance of scientific relations with other nations. In this matter it works with the Defense Research Policy Committee.

There is an interlocking membership with the Defense Committee. This is a committee for which we have no analogy in our scientific organization. We have no committee whose concern is to see that

proper Government scientific policy is formulated. We have no group that decides what particular aspect of science we lack as a Nation.

Mr. LANIGAN. Could I ask you this? Doesn't the National Science Board, which heads the National Science Foundation and the President's Advisory Committee on Science, don't they deal with those functions?

Dr. TURKEVICH. They may have the authority but they have not been very effective in dealing with future planning.

Mr. LANIGAN. Why do you say that?

Dr. TURKEVICH. There are certain areas of research where they have not showed leadership. These are certain areas that should be explored thoroughly. You have not seen any pronouncements by either of those committees saying that the United States should move into this or that area of scientific research.

Furthermore, I think they are weak, in that they do not have the laboratories to carry out their own ideas. If they have an idea they wish to carry out or a program to follow, they have to find somebody to do it outside their organization.

This is different in the British setup. The British scientific group has national laboratories where it can carry its ideas out.

Mr. POLAND. Do you think they have the jurisdiction to map out this area or do they lack the congressional mandate?

Dr. TURKEVICH. I am not quite sure of where the trouble is. The fact is they are not showing leadership.

The research establishments of the Department of Scientific and Industrial Research are 14 in number, with a large number of laboratories. They cover every phase of research and development required by modern economy. The establishments are: national physical laboratory, geological survey and museum, building research, chemical research, fire research, food investigation, forest products, fuel research, hydraulic research, mechanical-engineering research, pest infestation, radio research, road research, water polution.

Each of the above research organizations is under the immediate control of a director of research, who, in turn, is advised by the Board appointed by the Lord President. This advisory board is composed of independent scientific and industrial members, together with assessors representing appropriate departments outside the Department of Scientific and Industrial Research.

The function of the Board is to supervise in general terms the work of the individual laboratories and to make recommendations.

In 1952 the budget for the Research Establishment was £5 million.

The Government in the United Kingdom supports industrial research, through cooperative research associations. These autonomous bodies were formed to serve the need of particular industries and receive up to one-third of their financial support from the Department of Scientific and Industrial Research.

As I shall point out later, industrial research is very weak compared to that in the United States. The Government supports a considerable amount of it.

Support of university research is a minor activity of the Department of Scientific and Industrial Research (DSIR), since it is a major responsibility of the University Grants Committee. The DSIR makes grants to individual workers for special investigation by supporting graduate research students. Its support was about £640,000.

Industrial research is not as extensive in the United Kingdom as it is in the United States. There are various reasons for this. In the first place, the industrial establishments in Great Britain are small, with 75 percent of the firms employing less than a hundred.

Furthermore, the importance of research is not appreciated by the British Management since less than 7 percent of all industrial firms have a management staff with any technical experience or training.

Another difficulty is that the present economy of Great Britain does not have sufficient risk capital available to erect new plants based on reasearch success. Therefore, the incentive to do large scale research is lost. Much research and development turns to work on small and more immediate items which can be readily developed and sold. Although, about 1,500 industrial organizations are engaged in research it tends to be confined to a few large industries in the United Kingdom.

The Imperial Chemical Industries, Ltd., spends about £4½ million on research and £2½ million a year on associated development. Other companies that have extensive research programs are, Metropolitan Vickers Electrical Co. and the General Electric Co., Ltd. (not affiliated with the General Electric Co. in the United States).

Saturation has been reached in most of the companies in the ability to expand their research activities. The existing research potential is used by Government contracts.

There are about 45,000 people in industrial research, with only one-quarter possessing university degrees. This should be contrasted with the situation in France, where there are only 15,000. These are very small figures. This is why the United Kingdom and France are not in a competitive position with respect to the scientific manpower of the Soviet Union and of the United States.

The distribution of manpower among the various fields is chemistry, about 38 percent; engineering, 35 percent; physics, 11 percent; and metallurgy, 5 percent.

Five years ago industrial research and development expenditures were about £50 million. As mentioned before, research associations are autonomous groups formed by small scattered companies to fill the research and development needs of a particular class of industry. They are financed by industrial members, and by Government aid to the amount of one-third (through the DSIR). There are 40 such research associations and a considerable part of the industrial research of the United Kingdom is carried out by them.

The policymaking and general management functions for each research association reside in a council composed mainly of members drawn from the industry but also involving Government representation. There is a director of research in charge of each association, and they usually have but one laboratory. The results obtained by the association research and development program is not made public, but it is reserved for the use of the individual members.

The Department of Scientific and Industrial Research interferes as little as possible with the affairs of the research associations. This is the situation in the United Kingdom on military research, civilian Government research and industrial research. About 75 percent of all of the research is supported by the Government.

An interesting feature of the Government participation and one, I think you gentlemen will appreciate, is the Parliament and scientific

committee organized in 1939 to assist in the solution of political problems associated with science.

The committee is nonpartisan and acts as a liaison between Parliament and all Government, public, and private scientific organizations. The membership consists of 200 members of Parliament (from both the House of Lords and House of Commons), and about 75 members from scientific groups.

The chairman is a member of the party in power, with the deputy chairman a member of the opposition.

There is a paid permanent secretary.

The purpose and objective of the committee has been defined as follows:

> It is felt that substantial benefit should result if numerous societies concerned with scientific activity combined their influence with the object of assuring that Parliament shall have proper regard for the importance of scientific methods in relation to public affairs. Steps will be taken by the committee to enlist interest and support of as many scientific societies as possible so that the influence of science can be made as effective as possible in the councils of state. The committee will also endeavor, among other things, (1) to provide members of Parliament with authoritative scientific information from time to time in connection with debates; (2) to bring to the notice of the members of Parliament and Government departments the results of scientific research and technical development which bear upon questions of public interest; (3) to arrange for suitable action through parliamentary channels whenever necessary to ensure the proper regard is had for scientific points of view; (4) to examine all legislation likely to affect the above and take such action as may be suitable; (5) to watch the financing of scientific research; (6) to provide its members and other approved subscribers with a regular summary of scientific matters dealt with in Parliament.

This is an unique situation in that the legislative branch of the Government has its own advisory and liaison committee. I certainly think this is something worth establishing in the United States, for the help of Members of the Congress. It is a very interesting Government organization. I think it points up an important link between government and science—a liaison committee between scientists and the legislative branch. We all must concede that the British Government has a wide experience in the democratic organization of governmental activity.

Among the topics of parliamentary discussion of this committee, particular attention has been given to increase of productivity in industry, the time lag between discoveries and their application, the burden of taxes, the lack of capital, the shortage of manpower.

Mr. POLAND. Do you think they have done anything about these questions raised?

Dr. TURKEVICH. The fact that they have discussed them is a public educational process. You also have a permanent group advising the legislature. It meets once a month. How effective it has been, I don't know, but you certainly have a mechanism whereby a member of Parliament can get information directly, he can get the point of view of the scientists both in government and in industry. This is lacking in our Government organizations right now, except through sessions like this one.

Mr. JONES. In other words, they know something about tomahawks?

Dr. TURKEVICH. Which tomahawk?

Mr. JONES. Well, Mr. Cannon yesterday, in a speech before the House, made the disclosure that they had classified information as to the use of tomahawks, so I wondered how Members could get information about tomahawks.

Dr. TURKEVICH. Maybe through this, Mr. Chairman. I don't know.

Another interesting feature of the British experience is their method of handling research expenditures and the budget. It has been a matter of some concern here. How do the British organize this matter? The process of appropriating money for research is very different in the United Kingdom from that in the United States.

Parliament has little to say about the details of the budget. The Chancellor of the Exchequer reads his budget and the Parliament must either accept or reject it, in toto. The latter is very unusual for it means automatically the fall of the government. There is, however, a select committee on estimates which chooses some portion of the budget each year and studies it thoroughly. It has no power other than advisory and exerts its influence by publishing its findings.

Thus, the legislative body in the United Kingdom does not exercise any direct action on the research budget.

The budget is generated from the bottom upward. The directors of the laboratories make their estimates and justify them to their headquarters. The latter forward them to higher levels until they are brought to the ministers. The budget for the individual ministries is basically that of the preceding year. Only a small fractional increase in the budget can be justified because of the limitations on men and materials. The individual ministers have been previously forewarned by the Chancellor of the approximate amount of money they may expect to receive for their ministries.

Since the request from the different laboratories are usually higher than the money alloted by the Chancellor, the Minister must cut or justify the increase.

When cuts are made, whole projects are cut out rather than having each project whittled down. The advisory committees: The defense research committee and the advisory council on scientific policy usually determine the priority of the work. This is where these committees exercise a tremendous influence in directing research in the United Kingdom.

The Treasury officials occupy a powerful position since all major projects must be justified before formal formulation before the appropriate research and development section of the Treasury.

Many departments can make fiscal arrangements with the Treasury on a 5-year basis making possible long-range planning.

This unique feature of the British organization cannot be carried over to the United States.

There are 22 universities, of which only 12 existed before 1800. The university population in the United Kingdom is only 85,000 people. Seventy percent of all of the students in the British universities are on subsidy and the money that is given to the universities is voted by Parliament to a University Grants Committee. This University Grants Committee is composed of people from the universities. They distribute Government money among the 22 universities after consultation with the presidents of the universities.

Many people in this country have pointed this out as a very wonderful way of Federal support of the universities. However, you can

see this would be a very difficult thing to carry out in this country. In Britain there are only 22 universities and this is a manageable setup. In the United States with 1,500 colleges this would be just about impossible to manage.

Let us not forget that in Britain only a small segment of the population receives higher education. This arrangement of Government support which looks very well on paper is causing Great Britain tremendous difficulty in expanding their educational plant. Britain has no tradition (except for Cambridge and Oxford) for a private university and consequently if she expands her higher educational system by a factor of 10, she would be in financial difficulty. Out of the 35 million pounds spent by the universities on educational research, 29 million comes from the Government. Thus not only are the students subsidized, but also the universities are almost completely subsidized by the Government for research and development.

There are about 4,000 graduate students, a very low figure.

This completes the material I wish to present on the United Kingdom. As you see, there are some interesting features in it. It is a very sophisticated way of organizing Government research in both the military and civilian fields.

I didn't mention the atomic energy field. This is a separate field of work in the United Kingdom under the authority of the Atomic Energy Establishment.

One of the greatest features of the British system is the interlocking membership of the various committees. I think we should also appreciate the fact that scientific policy is set at a much higher level of Government in the United Kingdom than in the United States.

Mr. LANIGAN. Could I ask a question there about this interlocking membership? Don't we have interlocking membership on our committees in the United States?

Dr. TURKEVICH. But not at that high level.

Mr. LANIGAN. I think the significant thing is not only the interlocking nature, but the fact that you have a substantial number of high Government officials—I mean policy-making people on the committee, rather than sitting aside and following it. They actually participate in the committee; isn't that right?

Dr. TURKEVICH. That is right.

Mr. LANIGAN. It would be as though the Secretary of Defense, possibly, would be a member of the committee and his deputies would actually be members of the committee and not just listened to it.

Dr. TURKEVICH. Or have an advisor who sits on the committee and then reports to the policymaking official.

The situation in the Soviet Union is completely different. It reflects again the character of the Soviet system and the Communist scheme of highly bureaucratic centralized control. In the Soviet Union, everything is done by the Government. There is no question of private support of research, of industrial support of research. In England, 70 percent of the students receive scholarships, in the Soviet Union every student receives a scholarship.

There are other factors about the Soviet system which have to be kept in mind, since they are not appreciated in this country. When a Soviet student receives support in the university, not only for his tuition, but also for his living, he doesn't get this for nothing. Every Soviet university student, upon completion of his university work,

has to spend 3 years working for the Government, at places where the Government sends him. Their scholarship plan is not a give-away scheme. It is very similar to what we have in a limited area of student support in our universities. Both the Air Force and the Navy support students through the universities and then ask them to serve in the Air Force and Navy. But in the Soviet Union, all students have to serve.

Mr. LANIGAN. What happens after the 3 years? What freedom of choice does a student have after 3 years as to where he would work?

Dr. TURKEVICH. I have asked one top Soviet official on this and he said they usually stay where they were sent. This is an aspect peculiar to the Soviet system. We must keep it in mind: It is consistent with their whole philosophy. It is a system which we can't use, the British wouldn't use, and the Canadians wouldn't use. This is a different type of a country and a different type of government.

Mr. DAWSON. If they didn't stay where they sent them, there would not be much opportunity for them to use what knowledge they have gained or learned. The Government controls everything.

Dr. TURKEVICH. That is right.

Mr. JONES. It would be just like a ball player in the American League, wouldn't it, Mr. Chairman?

Dr. TURKEVICH. Soviet science, as most activities in the Soviet state, is highly organized and under direct Government control. Research is carried out under the auspices of the U. S. S. R. Academy of Sciences. At academy institutes the Ministry of Higher Education at the University laboratories, and under various specific Government ministries at plant laboratories.

The U. S. S. R. Academy of Sciences, expanded successor of the old Imperial Academy of Sciences, stands at the top of the research activity.

Because of the nature of the Soviet system, we have very little information about how their military research is carried out. There is, however, a very interesting sidelight on how the scientific people operate in their military establishments. Their top scientists, dealing in fields of military interest, have the rank of general, major general, lieutenant general, and wear uniforms. Consequently they must have prestige in the military establishment because of the visible rank that they have.

We thus have two extremes: The Canadian system where civilians completely control research, and the Soviet system where scientists become military personnel.

Mr. DAWSON. And pay them accordingly?

Dr. TURKEVICH. Yes, and they wear the uniform, have the prestige it confers, and can hand out orders to the military.

Mr. POLAND. Can you tell us how the academy is constituted?

Dr. TURKEVICH. The U. S. S. R. Academy of Scientists is a self-perpetuated organization of 150 academicians and 325 corresponding members who, according to basic Soviet law, are responsible for basic scientific and scholarly work in the U. S. S. R. We have in this country the National Academy of Sciences; the British have the Royal Society. Neither of those two organizations occupy a key place in scientific work of their countries that the Academy of Sciences occupies in the Soviet Union.

This is where all control of pure scientific research and possibly some of the military applications is coordinated.

Mr. POLAND. What are the perquisites of the members of the Academy of Science?

Dr. TURKEVICH. The academicians are elected by the general assembly and from what I can determine, most of them are elected for merit. Membership in the academy carries a tremendous amount of prestige and financial advantages.

On election to membership to the Academy of Sciences of the Soviet Union, one receives 5,000 rubles a month for the rest of his life.

One can gage the value of this from the fact that a laborer gets from seven hundred to a thousand rubles a month. This 5,000 rubles a month is in addition to whatever else one gets as a director of a laboratory, as a professor. It is extra compensation for the rest of one's life. Even people who have been in disgrace have received this stipend.

If one is a corresponding member, he gets each month two and a half thousand rubles for the rest of his life. The member of the Presidium—the executive committee of 25 members of the academy—receives 12,000 rubles a month.

Mr. DAWSON. This is in addition?

Dr. TURKEVICH. Yes, instead of 5,000, they get 12,000 rubles. The president of the academy gets 35,000 rubles a month. He is President Nesmeyanov.

Mr. LANIGAN. What would be the dollar equivalent of that?

Dr. TURKEVICH. I consider seven rubles equivalent to a dollar. The value varies between 4 and 7, but one must also consider what other people are getting. Scientific positions are prestige positions in Soviet society.

A statement has been made that the president of the academy of the Soviet Union is the highest paid individual in the Soviet Union.

The academy is divided not only in the scientific sections of physics, mathematics, chemistry, geology, biology, and engineering, but also in sections of history, philosophy, economics, law, literature. Great prestige is attached to the membership in the academy and I have given you how much they receive. This grant is given in addition to whatever income the member may receive from his research or teaching position.

Membership in the academy also carries with it special privileges such as superior housing, both in Moscow and in the country.

It should be noted, that the income tax in the Soviet Union is less than 5 percent, so they keep most of this money.

Election to the membership is by secret ballot and in most cases has been for recognized scholarly accomplishments.

There have been several cases where they have elected people of questionable scientific reputation like Lysenko, but these have been very small in number.

The governing body of the academy is the presidium, composed of the president of the academy, Professor Nesmeyanov; the secretary-general, Topchiev, and eight academician secretaries from the different sections of the academy. The presidium advises Government agencies, formulates the scientific program, passes on research proposals, authorizes funds and personnel for the various institutes and evaluates the results obtained.

Over and above this detailed direction, the presidium is guided by two principles. The first is the search for key problems, those research problems whose solution will open the maximum paths for future scientific development.

This is the point I made before, Mr. Chairman. As one looks over science one finds that certain areas are going to break soon. The Soviets are looking for those developments in science. They have a very fine scientific intelligence and evaluation program. They scan our literature and the literature of the West far better than any of us do. They say, "We have to push this particular development, we are going to find out what everybody else has done in this area, it looks as if the problem will crack if we put a little extra effort on it." Then they just throw personnel, money—and they try to crack the problem. This is the explanation for their advances in atomic energy, for their advances in the missile program. They don't scatter their shots all over the scientific targets as we do. They stand upon our shoulders and shoot at definite goals.

Mr. DAWSON. What cure would you have for that? What can we do to protect ourselves?

Dr. TURKEVICH. We do the same thing.

Mr. DAWSON. Regiment our country?

Dr. TURKEVICH. No; not regiment our country; but have our top planning group, whether it is the National Academy, whether it is National Science Foundation or any organization like that, ask itself the question, direct itself to the problem, "What are the important things we have to do in science, what is the next target the Soviets are going to try to hit," or better still, "what is the next scientific problem that is going to break." Instead of worrying about what the Soviets are doing, let's get ahead and do some of these things ourselves. It is obvious to some of us just where the big breaks are going to come. We have to try to take advantage of these situations.

Mr. LANIGAN. We were told that the National Science Foundation research is based upon the requests that come to it from the scientific community.

Dr. TURKEVICH. Right.

Mr. LANIGAN. And consequently its grants are not based upon a program, an aggressive program of its own, but upon requests that come to it. As I see it, your suggestion would be that more leadership be supplied by whatever agency is financing the scientific research; is that right?

Dr. TURKEVICH. Yes. I wouldn't displace the grassroots approach that we have right now.

Mr. JONES. What you are saying is that these functional responsibilities be put into a single scientific group or body to carry out, rather than having them dispersed in all the agencies and bureaus of the Federal Government?

Dr. TURKEVICH. And lost.

Mr. JONES. And lost.

Dr. TURKEVICH. Well, I will cite a particular problem I think we have right now in the atomic age. Considering both nuclear fission and fusion energy, we have the possibility of supplying enough energy for mankind for all conceivable future time. For everybody in the world, there is enough energy. Since the standard of living of a nation depends on how much power it has, and energy, there is a basis

for a wonderful world using this large pool of energy. On the other hand, you just can't eat energy; you need food.

Mr. JONES. Let me ask you a question off the record.

(Discussion off the record.)

Mr. JONES. We are on the record now.

Dr. TURKEVICH. There are certain things only the Government can do. It is just too big for any private enterprise. You take the problem of insurance against explosion of an atomic powerplant. You have it placed before you here in Congress, insurance against these nuclear disasters of these powerplants.

Mr. JONES. Well, haven't the English made far greater advancements?

Dr. TURKEVICH. But England is a socialistic country. Everything is run by the Government.

Mr. JONES. I am talking about the field of atomic research for domestic use of atomic energy. Haven't they succeeded far in advance of this country?

Dr. TURKEVICH. Well, it depends on what you mean by success. In that they have power, they are using and producing more power——

Mr. JONES. They are operating thermoplants about 4 or 5 years in advance.

Dr. TURKEVICH. Yes, but they needed them far more.

Mr. JONES. Yes, I know, but have they advanced far more than we have?

Dr. TURKEVICH. Yes, and the Government has done it all.

Mr. JONES. Yes; we can't make advancements in that field because we will step on somebody's toes. You have to figure out some way for someone to make a nice forward step.

Mr. DAWSON. The only thing sacred to some people in America is profit.

Mr. JONES. That is right, Mr. Chairman.

Dr. TURKEVICH. I feel this way about this matter: There are certain things the Government can do, certain things big business corporations can do, and certain things small groups do, certain things for individuals.

Mr. JONES. I am not suggesting to you that we use private research resources, but when we employ them, that doesn't mean that the Government has to be kept still and not excite their own potential of development.

Dr. TURKEVICH. Right, and I would like to see the Government go into competition with private industry and show them how it can be done.

Mr. DAWSON. Oh, you must not do that. If you want to do anything, you can give the money to them and let them be as leisure as they may be.

Dr. TURKEVICH. This is what I want, that we have a little competition in business. The Soviet Union, has this one advantage: They have centralized government planning for research and development. On the other hand, they have disadvantages that accrue from it. The system tends to be bureaucratic. Individuals lose initiative.

Mr. JONES. But they can make them work.

Dr. TURKEVICH. Yes; it is because they have the old whip behind them.

Mr. DAWSON. Regardless of what they have behind them, they get the job done and we with our stumbling ways, we find ourselves slipping back.

Dr. TURKEVICH. That is right.

Mr. DAWSON. How are we going to meet their competition?

Dr. TURKEVICH. One way to meet it is have a better organized team.

Mr. DAWSON. How can you do this as long as we have to depend on private industry?

Dr. TURKEVICH. I don't think we have to depend entirely on private industry. I think if you look at the records of science and research in this country that until recently——

Mr. DAWSON. What do you mean by "recently"?

Dr. TURKEVICH. Until the twenties.

Mr. DAWSON. I thought you meant to the change in the administration.

Dr. TURKEVICH. No, no, Mr. Chairman, I am just a poor university professor who can't get all of these political nuances. Until the twenties—let's make it more impartial—until the start of the 20th century, Government supported all the research in the country.

Mr. DAWSON. Sure, the Government supported it and then we had to get the Government out. The present policy of the Government is to take the benefits of the people and give it to big business, give it to the particular big business that might be in good graces with the party in power.

Dr. TURKEVICH. This is not what I am recommending.

Mr. JONES. Let me ask you this question: Do you think that the colleges and universities are going to continue to preserve academic freedom if there is a continuous setting up by private industries of the research programs that are carried out by these colleges and universities?

Dr. TURKEVICH. There is always the danger there, a big danger.

Now what I propose about the university——

Mr. JONES. Will you answer my question? I want to know if in your opinion the academic freedom is going to survive in these colleges and universities of ours.

Dr. TURKEVICH. Look, I am the president of the Princeton chapter of the American Association of University Professors and we are dedicated to the preservation of academic freedom. We still have it over there. We are standing up to these pressures.

Mr. JONES. Do you think there is any reason to be fearful of what is going on today?

Dr. TURKEVICH. We are concerned not only with the pressures brought by certain parties, by certain parts of industry, but also the pressures produced by alumni giving. This is another way, a subtle way——

Mr. JONES. I just talked to an industrialist not long ago and he was telling me in a most cheerful fashion of how he invested $5,000 in a chair at this certain university to carry out and propagate the idea or philosophy enunciated or supported by the National Chamber of Commerce.

Dr. TURKEVICH. It wasn't Princeton?

Mr. JONES. No, but it is going into the State university and the colleges.

Dr. TURKEVICH. Let's now look at another aspect of Soviet science. I claim, Mr. Chairman, that one of the sources of strength of the Soviet system is the fact that it has coordinated planning, that it has a tight little team that can be thrown into the problems they wish to solve. This is one of their elements of strength. It is far more important than the number of scientists they turn out; it is far more important than their educational system. They have the ability to pick certain targets, throw their men at them, throw their material in. This approach is easy to carry out in a Communist state such as they have.

Mr. POLAND. Excuse me. You left an unfinished sentence and my curiousity is still piqued. You said, "You can't eat energy."

Dr. TURKEVICH. I was coming back to this problem at some other point, but I can take it up now. We must realize that the world has now sufficient energy. Since the standard of living in any country is associated with how much energy a man has in a given country. Having a large amount of energy is desirable.

We in the United States use about 45 kilowatt-hours of energy per day. A savage, or a man working and doing manual labor, produces about a half kilowatt-hour per day. This gives him a very meager existence. There are two ways by which people can have the high standard of living we have. One is by having slaves and colonials, and the other way is by using the fossil fuels.

Now since the fossil fuels are being used up, the uranium and the thermonuclear energy is going to solve the energy problem. However, we can also solve the food problem if we do a little research. Most of the food is made by the plant by photosynthesis. This is a chemical process and with a little more money for research it is posable to just ship food over the world and we will lose another battle laboratories.

If the Soviets beat us in this particular job can you imagine what a tremendous impact it will have in the East? The Soviet Union will be able to just ship food over the world and we will lose another battle in the science war.

Now who in the United States is doing this type of research on a wide basis. This is what bothers me. There are other such problems. We must have some permanent organization with laboratories to implement this type of scientific leadership and not leave it to the vagaries of either private organizations or universities.

The other impact feature in the Soviet system is the constant plea for applying scientific discoveries for building up the communistic state. Now fundamental research is carried out in 126 institutes of the academies. They are very well equipped and I have statistics on the organization.

Now what I will do is make this part of my article here a matter of record and we will have that put in.

Mr. DAWSON. Fine.

(The document reads as follows:)

Soviet science, as most of the activities in the Soviet state, is highly organized and is under direct Government control. Research is carried out under the auspices of the U. S. S. R. Academy of Sciences at the Academy Institutes; under the Ministry of Higher Education at the universities; and under various specific Government ministries at plant laboratories. The U. S. S. R. Academy of Sciences, expanded and vitalized successor to the Imperial Academy of Sciences, stands at the apex of pure research activity. The U. S. S. R. Academy of

Sciences is a self-perpetuating organization of 150 academicians and 325 corresponding members who, by basic Soviet law, are responsible for scientific and scholarly work in the U. S. S. R. The academy is divided not only into the scientific sections of physics-mathematics, chemistry, geology, biology, and engineering, but also into the sections of history and philosophy, economics and law, literature and linguistics. * * * The governing body of the academy is the presidium composed of the president of the academy, Alexander Nikolaevich Nesmeyanov, the secretary-general A. V. Topchiev, and eight academician secretaries from the different sections of the academy. The presidium advises Government agencies, formulates the scientific program, passes on research proposals, authorizes funds and personnel for the various institutes and evaluates the results obtained. Over and above this detailed direction, the presidium is guided by two principles. The first is the search for key problems, those research problems whose solution will open the maximum paths for future scientific development. The second is the constantly insistent plea to apply scientific discoveries for building up the communistic state. This plea is implemented in a number of ways. There are the crash programs on major objectives such as atomic energy, aeronautical sciences, calculating machines. Yearly psychological rallying points are proposed and these may take the form of "Reexamination of science in the light of the decision of the 1948 Agricultural Congress (genetics controversy)," "Science building dams and hydroelectric stations," "Science as an aid to agriculture," "Science helping the reforestation program." In recent years these large diffuse objectives have been replaced by a smaller number of more specific tasks such as rapid digital machines, problems in the theoretical physics, automatic control of production, electronic and semiconducting devices, catalysis, protein chemistry, high temperature alloys, and power production. Fundamental research is carried out at the 126 institutes of the academy. These laboratories are well equipped with fine scientific equipment often of Soviet manufacture. The working area of the academy has been expanded during the last 5-year period by 103,000 square meters. Most of the institutes are situated near Moscow. The academy employs 35,000 persons. Of the 13,676 scientists, 150 are academicians, 326 are corresponding members of the academy, 1,216 have a doctor's degree and 5,187 that of the Kandidat. There are 2,863 Communist Party members on the rolls of the Academy. During the last 5-year period the academy employed 6,329 new specialists of whom 510 were new physicists, 555 chemists, and 1,700 specialists in new techniques. The ratio of technical assistants to scientists has risen during the last 5 years from 1 to 2 to the ratio of 2 to 3. Research is also carried out at the laboratories of the universities and engineering schools under the Ministry of Higher Education. However, the scientific accomplishments of the universities, with the exception of those of Moscow, Leningrad, Kiev, and Kazan, are of minor importance compared to the work of the academy institutes. This is in marked contrast to the situation in the United States and in Western Europe where most of the basic research is carried out at the university laboratories. In a recent address President Nesmeyanov called the attention of the academy to the fact that most of the great scientific discoveries had been made in the West in the universities and that the Soviet Union should expand its university research activity. Applied research is carried out in the many laboratories associated with various Government ministries. Research connected with problems specific to different Union Republics such as Ukraine, Armenia, etc., is performed in the laboratories and institutes of the academies of Union Republics. A coordinating committee of the U. S. S. R. Academy and an interlocking leadership permits close cooperation between the main U. S. S. R. Academy and the local groups. In recent years the academies of satellite countries have exchanged delegations with that of the Soviet Union. A most recent attempt to bind satellite science firmer in a Soviet orbit is the organization of a nuclear science center near Moscow for the satellite countries. Secretary general of the academy, A. V. Topchiev, an organic chemist, has been named director of this center.

Dr. TURKEVICH. Now I would like to make, in conclusion certain recommendations in connection with your committee's studies of Government organization of science. First of all, I would like to point out that it is very important in this coming decade, when scientific work is going to dominate not only the military situation, but also the economc situation, that we in this country utilize the tremendous scientific potential that we have available right now.

I have traveled as the National Sigma Xi lecturer through the various colleges of the country, through the Middle West—not only the very big ones, but some of the small ones. I found that there are very fine scientists, some very fine students who could help us if we told them what to do. Nobody seems to tell them what the country needs or advise them just what the important things are in science. They are not given sufficient support.

Mr. DAWSON. What do you mean by "sufficient support"?

Dr. TURKEVICH. I was down last week as the National Sigma Xi lecturer at Nashville, at Fisk University and also at Vanderbilt University. There are some fine scholars in these institutions. They are good scientists. Nobody gives them any attention, tells them what they could do, advises them how to look at this problem. We as a Nation have this problem in connection with development of rocket fuels; "Will you, Professor So-and-So, who have a laboratory, give us some help?"

There is no coordination from top to utilize this available help, to pass the information on.

I went to Bowling Green University. I was there on a Saturday afternoon. People were working doing research, but the research was not one that was directed toward ensuring our national survival. Not that the scientists did not want to help.

Mr. DAWSON. What was it directed to, may I ask?

Dr. TURKEVICH. They were just measuring something. I am not asking that we have solely a planned research; what I am asking is this: That we have some means of communicating to the grassroots of our country what the important scientific problems are so that they can help us solve them when they are willing to help. We have no method of doing this. The Soviets do this far more cleverly; they have information meetings, they call their people from all sorts of sections of the Soviet Union to present urgent problems.

Mr. DAWSON. But they have no competition. You have competition here from private business and they will offer the proper salaries to those who work on the thing that they want worked on. But the ordinary professor, what inducement is there to him to go into these things that are not paid for by the private industry?

Dr. TURKEVICH. I wish to present to you some findings that I feel are relevant. A survey has been made of the reasons why scientists leave teaching in small colleges to work for industrial research organizations. They do not leave for higher salary. They leave because in the small colleges research is not appreciated.

Mr. DAWSON. Yes, but they get paid for what they know about research and they get a better price from private industry than they could get from the Government or any school, and they go. Certainly a man should go if he has the talent that is needed. They should go. What we have to do is this: In the first place we have to appreciate what those people engaged in research mean to the community and we have to give them some honors—money and so forth—to do it. Either the Government has to do it or private industry.

Now, should the Government subsidize these men in science, and point up to them the things that ought to be done? Do you say we must do that?

Dr. TURKEVICH. I think so.

Mr. DAWSON. Then that is socialism, too, isn't it?

Dr. TURKEVICH. You can't have your cake and eat it.

Mr. DAWSON. Big business will accuse the Government of dealing in socialism and promoting socialistic methods and so forth and then we are up against it once again.

Dr. TURKEVICH. That is right, but, look, we have to do something about it.

Mr. DAWSON. Yes, we have to do something, but make up your mind.

Dr. TURKEVICH. That is what I want to do. I want people in these various colleges to appreciate what the problems are. It is not necessarily giving them money.

Mr. DAWSON. Not only must the people in the colleges appreciate what the scientists means to the Nation, but the man on the street must come to appreciate them. Then the scientists must be given either rewards in money or honor or something to justify them.

Dr. TURKEVICH. I think there is more to it than that and it can be done much simplier. You know organization of science is lacking in our State and I——

Mr. DAWSON. In your State?

Dr. TURKEVICH. In our Nation really, rather than my State, I come from a big university where there is great prestige for doing scientific work. This is not so at the smaller colleges. We could give the scientists at the smaller colleges prestige if it is known that a national organization had come to them and asked them to help on a problem of national importance.

Mr. DAWSON. In the U. S. S. R., if they can give a man 5,000 rubles in appreciation for what he can do for the country, why shouldn't this country give some return for his services?

Dr. TURKEVICH. I agree with you.

Mr. DAWSON. Then how are we going to meet the competition? How are we going to do it? You are going to be accused of socialism.

Dr. TURKEVICH. I don't care what I am accused of. If it is right for the country, then you do it, but let the chips fall where they may.

Mr. DAWSON. I agree with you. Now how can we get some converts to that theory over here on the floor of this Congress?

Dr. TURKEVICH. There is one other point I would like to suggest in the area of the military research. I would like to see all laboratories in the Military Establishment put under a civilian committee and establish a new department in the Department of Defense. In addition to the Department of the Army, the Department of the Navy, the Department of the Air Force, have a Department of Defense Science and have the man in charge sit with the Joint Chiefs of Staff.

Mr. JONES. Would you have a department within the Department of Defense?

Dr. TURKEVICH. Right.

Mr. DAWSON. You believe the Army should be under civilian control?

Dr. TURKEVICH. No. In this new Department of Defense Science have a complete chain of command. This would also have a salutary effect in unifying those other three departments.

Mr. JONES. The authority is already vested in the Secretary of Defense, so why would you delegate it to an agency with a responsibility already vested there? It is inherent with the Department of Defense already, so whether you call it a bureau or group or whatever——

Dr. TURKEVICH. Just take all of the laboratories from the different Army establishments.

Mr. JONES. I thought you were going to come out for a Department of Science and have it available to carry out research, say the Atomic Energy Commission, if that kind of thing is needed, rather than setting up each activity in a separate branch or arm of the services or the departments of government.

Dr. TURKEVICH. I would have three divisions. I would have the Atomic Energy Commission working as it does now. I think it is doing a good job. I would have for military research within the framework of the Department of Defense a special Department of Science, complete civilian control of all scientific establishments devoted to military uses. I wouldn't mix civilian research with military research.

Mr. POLAND. Would you have that similar to the Canadian system in that respect?

Dr. TURKEVICH. Right.

Mr. POLAND. And the department you are now advocating then would have the power to allocate research within the Defense Department and would supersede the judgment of the Army, Navy and Air Force with respect to scientific research and development?

Dr. TURKEVICH. Right.

Mr. JONES. Doctor, if you had that kind of arrangement, the only thing that board could do would be take out military scientists. I thought you were talking about scientific advances on a broad field.

Dr. TURKEVICH. Then I would have a third one, a National Science Commission to take care of all civilian government research. That would supersede the National Science Foundation that would have, in addition to the powers of the National Science Foundation, have its own laboratories where they can carry out their own work. I would have the National Science Commission set up the same way as the Atomic Energy Commission is set up. I would have these three divisions of government.

Mr. JONES. Any further points, Doctor?

Dr. TURKEVICH. That is all.

Mr. JONES. Mr. Chairman, any questions?

Mr. DAWSON. No. We are only sorry this has been such a busy day that we could only have a short time devoted to Dr. Turkevich's statement. It has been a long time since we have had a witness who has been as interesting as the Doctor has been and who I think could give us some fundamental ideas on how this government ought to be run and ought to be set up.

Mr. JONES. I wonder if some questions occur to us later on if we could submit them in writing and you would accommodate us by giving your opinion and observation.

Dr. TURKEVICH. I would be very happy to and if you wish, I could formulate in writing my proposal.

Mr. JONES. I would appreciate it if you would and, without objection, it would be received and made a part of the record at the pertinent point just immediately preceding the conclusion of your statement, but I assure you, Doctor, it has been a refreshing afternoon to get your ideas and it is a subject that is so entirely foreign to me, I should apologize not only to the witness, but to you, Mr. Chairman, and members of the staff.

Mr. DAWSON. Don't apologize; you are doing all right.
Mr. JONES. Of the record.
(Discussion off the record.)
Mr. JONES. The subcommittee is now in recess.
(Whereupon, at 5:05 p. m., the subcommittee adjourned.)
(The proposal referred to above follows:)

PROPOSAL FOR THE REORGANIZATION OF SCIENCE IN THE UNITED STATES GOVERNMENT

There are four major divisions of Federal activity in scientific research and development:

1. Military area
2. Civilian area
3. Atomic energy
4. Agriculture.

It is proposed to keep the organization of research and development of science in its present state in the fields of atomic energy and agriculture but to introduce fundamental changes in the military and civilian fields.

Military research and development

Scientific research and development is in a very sad state in the Department of Defense. It is scattered among the Army, Navy, and Air Force installations. There is no coordination, resulting in unnecessary triplication of effort. The morale of the civilian scientists and engineers is low. It is administered by people with a military background with short tours of duty at research and development installations. The failure of the United States satellite and missile programs is a striking example of the degree of disorganization and ineffectiveness of the research and development in the Military Establishment. To remedy the situation the following radical reorganization is proposed for scientific and technical work in the Department of Defense:

A Department of Defense Science should be created within the framework of the Department of Defense. It shall be given responsibility for carrying out the scientific research and technological development necessary for the defense of the United States. The Department of Defense Science shall be on an equal footing to and independent of the Department of the Army, the Department of the Navy, and the Department of the Air Force. All military laboratories and arsenals carrying out research and development work in the Department of Defense, such as—

Aberdeen Proving Grounds
Englewood Arsenal
Missile Laboratory at Huntsville, Ala.
Signal Corps Laboratory at Mort Monmouth
Wright-Patterson Research Group
Cambridge Air Research Center
Sandia Proving Grounds
Naval Research Center

and so forth, and in addition the Office of Ordnance Research of the Army, the Office of Naval Research, and the Research and Development Commany of the Air Force, be transferred to this new Department of Defense Science.

A corps of defense scientific and engineering personnel shall be created from the scientists, engineers, and the military with technical background scattered through the Department of Defense. This corps is to carry out the research and development necessary for the military defense of the United States. The members of this defense science corps will work at the scientific research and development installations and can be transferred from one such installation to another as the requirements demand. The personnel of the newly created Department of Defense Science would have graded ranks equivalent to that of the military and enjoy the right to wear the uniform of the corresponding rank of the Army, Navy, or Air Force. (This is now done in the United States Public Health Serivce.) Within the Department of Defense Science there shall be a direct chain of responsibility leading through the scientists, division heads, directors of the laboratories to the United States Staff for Defense Science. This staff would have, among administrative responsibilities, the task of formulating policy and planning of research and development for the military defense of the United States. The Chief of Staff for Defense Science would have a rank equivalent to that of a general and shall sit on an equal basis with the Chiefs of Staff of the Army, Navy, and Air Force on the Joint Chiefs of Staff.

Officers from the Departments of the Army, Navy, and Air Force would be assigned to the Department of Defense Science both at the administrative headquarters and at the research and development installations to serve as liaison officers.

The Departments of the Army, Navy, and Air Force will have a limited number of research and development personnel of military rank to act as advisers in the policy formulation of their departments and to draw up research and development requirements for their branch of military service for transmission to the Department of Defense Science.

The Department of Defense Science will assume the obligations and powers of the agencies of the Army, Navy, and Air Force (such as the Office of Ordnance Research, the Office of Naval Research, the Research and Development Command of the Air Force) to grant moneys for research and development contracts to industry, research institutes, and universities.

There shall be a noncareer Secretary of Defense Science with a group of staff assistants. The Secretary of Defense Science shall have duties equivalent to the Secretary of the Army, Secretary of the Navy, and Secretary of the Air Force.

Scholarships will be granted by the Department of Defense Science on a competitive basis to qualified graduates of secondary schools. These scholarships will cover all the expenses for a 4-year course in science and technology at an accredited college, university, or engineering school. The recipient will be obligated to serve 4 years at the Department of Defense Science or its installations. If he chooses to enter graduate school for continuation of his work in science and engineering he can defer his service for a period not exceeding 4 years until he receives his doctorate degree. His service then to the Department of Defense Science will be reduced to 2 years.

There shall be a defense science college established on an equal basis to the three war colleges of the Army, Navy, and Air Force. Senior personnel of the Department of Defense Science will be trained at the defense science college for top administrative and policymaking positions.

The advantages of this reorganization of research and development in the Department of Defense through the creation of the Department of Defense Science are the following:

(1) A unified approach to the scientific and technological problems associated with the defense of the United States.

(2) Incentive to scientists and engineers by offering them a career leading to positions of high prestige, financial remuneration, responsibility, and authority.

(3) Guaranty of proper presentation of the scientific and engineering point of view at the top policy formulation echelons of the Department of Defense.

(4) Introduction of chain of responsibility and command whereby the policy, once formulated, can be implemented through an organizational path involving men of technical training and unobstruced by layers of military career men.

(5) Ability to shift scientific and technical personnel from one research and development installation to another one.

(6) Removal of the unnecessary triplication in personnel, projects, and administration.

Civilian Research and Development

In the United States civilian research and development is carried out at universities, research institutes, industrial laboratories, and Government laboratories. The National Science Foundation has been organized to foster research in the civilian area. It suffers from the following shortcomings: There has been a lack of leadership in bringing to the attention of the country, Congress, scientists, and engineers the important areas in which the country should carry out research and development. There has been no long-range planning for research and development. The wholesale granting of fellowships to first-year graduate students has dried up the supply in chemistry of part-time assistants in colleges for undergraduate laboratory teaching. Finally, the National Science Foundation does not have laboratories to carry out the long-range research projects.

It is, therefore, proposed that the National Science Foundation be changed over to a United States Civlian Science Foundation composed of five members appointed by the President and approved by the Senate. There shall be a chairman of this comimssion and a vice chairman serving full time while the other

three members will serve on a part-time basis. At least three members of the Commission will be outstanding scientists or engineers. There shall be a General Manager who shall report to the Commission and shall act as the Commission's administrative officer. The United States Civilian Science Commission shall have the responsibility of formulating the scientific policy of the United States in the civilian field, of bringing to the attention of the President and the Congress areas where the effort of the United States is inadequate, of overseeing in a general way through the budget the national science laboratories and of sponsoring scientific research and development and education by grants and fellowships to research institutions, universities, and industrial laboratories.

Five national science laboratories shall be organized for basic scientific research in sciences and engineering. They shall be administered under contract from the Commission by private corporations organized by groups of universities or industrial organizations much in the same fashion as the Brookhaven National Laboratory, the Oak Ridge Laboratory, and other laboratories are managed for the United States Atomic Energy Commission. These laboratories will carry out long-range scientific research supplementing the efforts of the universities and industrial research staffs. There shall be close liaison between the universities and the national laboratories by having part-time appointments of universty scientists at the national science laboratories and by having the national science laboratories grant advanced degrees.

It shall be required of all national science fellows that they do a certain amount of teaching at the universities and that no university department have more than five national science predoctorate fellows of the same age status: fist year, second year, and so forth.

(The following statement was submitted by T. F. Walkowicz of New York City for the use of the committee:)

STATEMENT OF T. F. WALKOWICZ, NEW YORK CITY

MILITARY RESEARCH AND DEVELOPMENT MANAGEMENT

The current focus on the effectiveness of military research and development, in view of the demands of the technological war between the United States and the Soviets, gives rise to two basic questions:

1. How can we manage military research and development effectively and efficiently, to insure the prompt application of important new discoveries to military weaponry and to provide for efficient utilization of research and development resources (people, facilities, dollars)?

2. How can we translate new discoveries into new weapons with the shortest lead time possible?

Various organizational proposals are being put forward at the moment for achieving these two vital objectives: the proposed Advanced Research Projects Agency, ARPA, in the Department of Defense; or a 100-percent civilian agency outside the Pentagon; or letting the Atomic Energy Commission or the National Advisory Committee for Aeronautics become a space agency.

In their present form, the various ARPA proposals reflect the same basic lack of understanding of military research and development which got the country into trouble in the first place. The executive and legislative branches of the Government, having slowed military research and development down to a snail's pace by enmeshing it in a bureaucracy of infinite inertia and incredible complexity, may now try to improve military research and development by setting up another, similarly enmeshed agency.

Present discussions regarding the AEC and the NACA are at least pointed in the right direction. However, they raise certain questions discussed below, and do not go to the heart of the matter; a major improvement in the effectiveness and efficiency of the entire military research and development program.

ARPA BEGS UNIFICATION ISSUE

The first argument used in support of ARPA is that, in the long term, it will eliminate competition among the services on an evolutionary basis. This begs the basic issue of real unification in the Pentagon.

Attempting to unify the Military Establishment on an evolutionary basis by only unifying long-range military research and development today constitutes an unduly cautious and conservative approach to unification. The problems of unification are well known; they have been debated for almost two decades now,

and everyone has had more than his say. It is clear that, in moving toward greater unification, there are certain basic dangers which we must avoid, e. g., we must not stifle constructive competition of new ideas in strategy, war planning, and new weapons development.

However, in the interest of effective direction of combat forces and prudent allocation of overall resources, it is clear that a greater degree of unification must be sought. If it is achieved, unification of research and development through the establishment of an ARPA-like operating agency at Defense Department level not only makes sense, but becomes a necessity.

With the present defense organization, any ARPA-like agency should be a policy- and decision-making organization only. In fact, two such organizations already exist: the offices of the Defense Director of Guided Missiles and the Assistant Secretary of Defense for Research and Development. However, like most other offices at the Department of Defense level, these offices are overstaffed in numbers and understaffed in amount of experience pertaining to the major problem areas; and, even if properly staffed, they could not function effectively until certain basic changes are made in the legislative and executive branches of the Government, as discussed below.

WHICH LEAD TIMES AND WHOSE LEAD TIMES?

The second argument used in support of an ARPA-like agency is that it would cut down lead time.

Lead time consists of three parts: planning lead time, i. e., getting a new weapon project started; development lead time, i. e., getting the new weapon developed and tested; and operational lead time, i. e., getting the weapon produced, training men in its use and maintenance, building bases, and organizing new combat-operational units.

Statements that United States planning lead time is much longer than that of the Soviets are not always supportable by the facts. Such statements, in effect, claim an effectiveness for United States intelligence activities which simply does not exist. Who knows when the Kremlin starts a new project, save the Kremlin itself?

To the extent that United States planning lead times do appear long, much of the delay can be attributed to the great number of small and higher officials, who must be sold before a project is initiated. Many of these men act like project officers, either because they don't have the authority to make major decisions (but can stop them), or because they don't understand the difference between policy and detail, or because they momentarily expect a detailed inquiry from higher up on behalf of somebody's constituent.

Regarding development and operational lead times, the nuclear age forces us to take the risks and pay the price of compressing these to the maximum extent possible. Thus, in new weapon programs of major importance, there must be a concurrent initiation of production planning and tooling, base construction, operational and maintenance crew training, etc., while that weapon is still in the early stages of development.

Placing advanced research and development responsibility in the hands of a fourth operating agency could make lead times even longer, by denying the military—as presently organized—the sense of responsibility and participation which they need to move a new weapon rapidly from the drawing board into combat units.

Congress and the Executive need merely do three things: First, designate the research and development programs of major importance and provide lump-sum budgets for their support; second, understand and accept the fact that there will be failures because of the very nature of the research and development business; third, avoid second-guessing the decisions of the competent man put in charge of a program, and do not pass laws or regulations which hamstring his operations. Given these three things, lead time will no longer be of concern to anybody.

CIVILIAN CONTROL OF ADVANCED RESEARCH AND DEVELOPMENT?

The argument for civilian control is based on the outstanding World War II success of the NDRC-OSRD, managed by civilian scientists under the leadership of Dr. Vannevar Bush. The military, the argument goes, are always too preoccupied with current problems to think sufficiently far ahead.

It is interesting to note that most of the examples of lags in new weapons development used in support of this thesis involve situations where some military

men, some civilian scientists, and some statesmen (in both parties) were on both sides of the question. For example, some military men, some scientists, and some politicians were for starting ICBM development in the mid-1940's; some men in each category were against the program during that period. The same situation existed at the time of the H-bomb controversy.

No one group is infallible; each needs and must work in harmony with the other two. Most of all, the military man, who, in the final analysis, must do the actual fighting, cannot be divorced completely from any responsibility for developing the tools of his trade.

It is true that the military, in spite of some progress, have yet to integrate civilian scientists effectively as full-fledged working partners in military research and development organizations. However, very few of the outstanding scientists have been willing to brave the frustrations of the administrative jungle which Washington becomes in peacetime. Some scientists have learned, to their great credit and to their sorrow, that it is rather more difficult to get things done today than it was in the free-wheeling NDRC-OSRD days of World War II. We must first create anew the proper administrative environment for military research and development, and then organize civilian and military scientists working together as a team, with each individual contributing according to his particular competence and skills.

THE NACA AND THE AEC?

The NACA is an outstanding organization, now doing basic research in aeronautics at altitudes from zero to infinity. One cannot go out into space without passing through the atmosphere first. Setting up a separate space research agency would generate unnecessary confusion, lead to wasteful duplication of resources which already exist, and demoralize the NACA's first-rate team of scientists who are already hard at work.

The AEC is also an outstanding organization, and it could provide an ideal administrative environment for military research and development work, as it already has in the field of atomic energy. In fact, the organizational recommendation made below is largely patterned after the AEC. However, if it is decided to make the AEC responsible for all military research and development, then the Army, Navy, and Air Force organizations, personnel, and facilities should be turned over to the AEC. Whatever the organizational setup eventually adopted, the vast research and development resources and programs of the Army, Navy, and Air Force must be rescued from the administrative morass in which they are now forced to operate.

STARTING IN THE RIGHT PLACE—AT THE TOP

Management improvement in military research and development must begin with certain basic changes in the Congress of the United States and the executive branch of the Government.

All Americans revere the Congress of the United States, as an enduring institution of free men and representative government. Similarly, every citizen wants prudent management of resources and accepts the need, in the executive branch of the Government, for a Bureau of the Budget and for an Assistant Secretary of Defense—Comptroller. However, certain basic changes in these areas are long overdue.

RECOMMENDATIONS FOR THE CONGRESS OF THE UNITED STATES

1. Put the military research and development budget on a 2-year basis

Both the members of Congress and the officials of the Defense Department are literally killing themselves to do an inadequate job, under today's 1-year budget basis.

The typical defense official spends a half year preparing dozens of versions of each new budget, and he spends another half year defending it. He actually has to begin preparing the following year's budget while he is still defending the previous one. There is little or no time left, for Congressmen and Defense officials alike, to see that research and development programs are properly executed.

With a 2-year budget, about half the time of key officials would be available to see that the money is spent wisely. In the event of unforeseen occurrences, both the Congress and the Defense Department would be free to review research and development programs at any time.

2. Put the military research and development budget and program on a lump-sum performance basis

Consider and vote on a package program which has only one account for research and development contract money, funds for procurement of prototypes for test purposes, pay of military and civilian personnel, construction of contractor and Government research and development facilities, overhead support of test installations, etc.

Once a package program of this kind is approved, Congress should give the research and development operating agency reasonable freedom in transferring money between accounts. Congressional checks on progress should be limited to periodic reports on major successes, failures, or program changes; e. g., Was the first ICBM test-fired on schedule? When will the first nuclear-propelled airplane fly? Why was project XYZ canceled?

This would be a bold step for the Congress. But Congress has done it before in specific instances; e. g., the atomic bomb program in World War II.

Congress must now face up to doing it for the entire military research and development program, because we are in a technological war with the Soviets. And our effectiveness in fighting that war is seriously compromised by Congress' methods of providing the required resources.

For example, it now takes 5 to 8 years to provide research and development facilities via the military construction program—Corps of Engineers—cycle, and the facilities are sometimes obsolescent at best when they come into existence. Such lengthy delays may be tolerable in such peacetime projects as dams, flood control, highway construction. In the research and development program, these delays can prove to be our Achilles heel.

3. Revitalize the free-enterprise system

Congress ought to conduct an investigation to determine to what extent the administrative practices forced upon the Defense Department by legislation and by various Executive orders actually vitiate the effectiveness of the free-enterprise, incentive system which has made this a great industrial country. Defense industries cannot risk large amounts of corporate funds on new weapon developments, when profit margins are very low and unknown until renegotiation boards have taken several years to determine them. Nor can industry accept financial penalties for failure, if there are no rewards for success.

Industry is prepared to risk its funds for research and development and would, if both military contracting officers and the Bureau of Internal Revenue would not contest normal business-expense writeoffs of investments for this purpose, and if armed services procurement regulations did not operate to weaken patent rights.

RECOMMENDATIONS FOR THE EXECUTIVE BRANCH OF THE GOVERNMENT

The basic problem in the executive branch is that there are too many people second-guessing those in charge of the research and development operating agencies. There are too many people who can stop a program, but who have no responsibility for its success. For example, both the Bureau of the Budget and the Assistant Secretary of Defense—Comptroller have, from time to time, withheld funds for specific projects.

Using an industry parallel, if the vice president—finance and treasurer of a company proceeded to hire technical people to second-guess the budgetary estimates of the vice president—engineering and to mastermind the technical details of his programs under the guise of financial management, one of two things would happen: either the vice president—finance and treasurer would be fired, or the company's business prospects and earnings would deteriorate rapidly, and the shareholders would want to know why.

If the executive branch has so little faith in the managers of their military research and development programs that they feel the need for watchdogs, they should remove the research and development managers and replace them with competent men. Or, if the financially trained watchdogs are so competent, they should be put in charge of military research and development programs and given an opportunity to prove that they can do better.

Finally, regarding the executive branch, it is high time that we got away from the apparent feeling that a successful Secretary of Defense would be handicapped by any real understanding of modern defense weapons. To be quite specific, this country has spent some $200 billion on defense in the last 5 years, and surely at least half of that has been expended in the field of aeronautics. Most of the great aeronautical pioneers and industrialists of this country have

been lifetime Republicans, and yet, during this period, not one of them has been offered a responsible defense job by the administration.

From all reports, the new Secretary of Defense is an outstanding executive. Yet it is not uncomplimentary to him to point out that, for lack of background in the important technical fields, he will still be learning the basic terminology of his business a few years from now, when he leaves office.

Again by way of industrial comparison, how many investors would buy the shares of General Motors if they knew that only very few of the officers or executives of the corporation had had any previous experience in the automotive business? The taxpayer, a one-vote shareholder in the United States, has a right to expect the executive branch to appoint Cabinet officers who can move in and act, instead of being on-the-job trainees.

RECOMMENDATIONS

1. Give a positive mission to the Bureau of the Budget and the Assistant Secretary of Defense—Comptroller. Make them feel the responsibility for providing for the dynamic growth of those portions of the Defense Establishment where science and technology are currently having their maximum impact.
2. Drastically reduce the number of kibitzers who have no responsibility for a program, but who have the administrative authority to stop it and force those in charge to rejustify it.
3. Infuse the Cabinet and the Defense Department with an appropriate number of indivduals who understand the dominant technologies of our time, and who can provide policy leadership in those areas.

With this background, a proposal is put forth for managing military research and development. It is written for the knowledgeable reader, without supporting argument. The knowledgeable reader will understand that this is but one proposal, and that many alternative organizations might be found equally suitable for achieving the two basic objectives outlined above.

Proposed Military Research and Development Commission

It is proposed that there be established a military research and development commission, similar to the Atomic Energy Commission, as a military research and development management agency.

For brevity, the military research and development commission is described by comparing it with the AEC, and bringing out important differences and similarities.

1. The Chairman of the Military Research and Development Commission would be a civilian-scientist administrator, as would be a majority of the Commissioners. However, technically competent military officers in uniform (i. e., still on active duty), would be qualified to serve as Commissioners. (In the AEC, active duty officers have not served above the division level.)
2. The Chairman of the Military Research and Development Commission would report to the Secretary of Defense, rather than directly to the President. However, the Chairman of the Military Research and Development Commission would also have access to the special assistant to the President for science and technology.
3. So long as there is no further unification of the Department of Defense, the Military Research and Development Commission would be solely a policy decision-making organization. Its total staff would consist of 1 assistant and 1 secretary per Commissioner. In addition, it would have a scientific advisory board of about 20 outstanding men, with about half of this number drawn from the present membership of the Army Scientific Advisory Committee, Naval Research Advisory Board, and USAF Scientific Advisory Board. Policy decisions made by the Military Research and Development Commission with respect to research and development programs, budgets, and administrative practices would be made binding upon the research and development organizations of the Army, Navy, and Air Force.
4. In the event that unification of the combat-operational forces is implemented, the Military and Research and Development Commission would become an operating agency, and the current operating research and development organizations and personnel of the Army, Navy, and Air Force would report directly to it.

5. The Military Research and Development Commission would have the same freedom as the AEC to set up its own personnel system, contracting procedures and regulations, and administrative practices. The Military Research and Development Commission would get the bulk of its work done by contracting for it, just as the AEC does now.

6. Civilian and military scientists and personnel would serve in the Military Research and Development Commission in a mixed organization, much as they do now in the AEC, each individual serving according to his particular qualifications. Assignments of military personnel to the Military Research and Development Commission would generally be for 5-year tours, and the Military Research and Development Commission would be free not to accept for assignment a military person not considered qualified.

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